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LOWER SILURIAN SYSTEM

OF

EASTERN MONTGOMERY COUNTY, NEW YORK

BY

E. R. CUMINGS

NOTES ON STRATIGRAPHY

OF

MOHAWK VALLEY AND SARATOGA COUNTY NEW YORK

BY

CHARLES S. PROSSER M. S.

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1900

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PREFACE

The accompanying papers by Mr E. R. Cumings and Prof. Charles S. Prosser embody the results of work prosecuted by or under the direction of the latter in connection with his duties as professor of geology at Union college. Both present some important additions to our knowledge of the lower Silurian formations. Prof. Prosser and Mr Cumings have found and delineated a clear line of division between the Utica and Hudson river formations in Montgomery county, a feature which has heretofore been obscure. Prof. Prosser gives with detail and precision a number of sections of the early Silurian strata in the Mohawk valley and Saratoga county, some of which have been less accurately recorded and others are here placed on record for the first time. The work of these gentlemen has been freely contributed for publication as a bulletin of this department.

JOHN M. CLARKE
State paleontologist

Albany 26 *April* 1899

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LOWER SILURIAN SYSTEM OF EASTERN MONTGOMERY COUNTY, NEW YORK

BY

E. R. CUMINGS[1]

Representatives of all the rocks of the typical American lower Silurian system, with the exception of the Chazy stage, may be seen within a radius of five miles of Amsterdam, in the eastern part of Montgomery county, New York. The city of Amsterdam is situated on the easternmost of the series of uplifts that intersect the valley of the Mohawk river between Hoffman ferry and Littlefalls, all of which have thrust the lower rocks of the system through the upper. The present paper deals with the lower Silurian system as developed in the vicinity of Amsterdam in Perth, Amsterdam and Florida townships of Montgomery county, and Charlton, Glenville, Rotterdam, Princetown and Duanesburg townships of Schenectady county. In order that the following part of the paper may be less cumbered with footnotes[2] a brief historic sketch and description of the system is here given in the following order:

Historical sketch and review of previous work

Calciferous sandrock. In his report on the *Geological and agricultural survey of the district adjoining the Erie canal* (1824) Prof. Eaton named the Calciferous sandrock, describing it as "an aggregate of quartzose sand and fine grains of carbonate of lime. . . The quartz is generally in the largest proportion" (p. 32, 33). He states in another place that "the most perfect locality as well as the most accessible to those who travel the canal is Flint hill in Florida township and its continuation two or three miles west. In this locality we find dark brown and pearly hornstone, brown and

[1]This thesis was submitted by Mr Cumings for honors in geology which were granted him by the faculty of Union college in June 1897. The accompanying geologic map of the Amsterdam sheet is the result of the work of Messrs Prosser, Cumings and Fisher.—*C. S. Prosser*

[2]Where volume and page references are given, the numbers are separated by a colon; e. g. 3:21 means volume 3, page 21. Where reference is to "part", pt 2, p. 401 is the form used.

pearly calc spar, very large masses of coarse agate, quartz passing into chalcedony, petrosilex and quartz crystals" (p. 73).

Substantially the same description of the Calciferous sandrock is given in Prof. Eaton's *Geological nomenclature* (p. 12-13).

In the *First report on the geological survey of the third district* Mr Conrad says "The general inclination [of the Calciferous sandrock] is 4° or 5° to s. w. which causes the rock to be generally lost to observation to the south of the Mohawk except upon the immediate bank of the river and that of the canal whilst it rises with the hills on the opposite shore, frequently however concealed by limestone."[1]

In the *Second report of the third district*, Vanuxem restates the features of the Calciferous sandrock, remarking that "this rock is very variable in character and composition, . . . and appears to contain more carbonate of lime in its composition at Tribeshill and in the small streams between Amsterdam and Crane's village than on the western side of Montgomery county.[2]" A few fossils are mentioned as occurring in the upper layers of the rock (p. 283).

In Vanuxem's final *Report on the third district*, the Calciferous sandrock is said to embrace three masses. The first is siliceous, compact, the second is a "mixture of fine yellow siliceous sand and carbonate of lime" and is the mass from which the name of the stage was derived, the third mass is a "mixture of Calciferous material which is usually yellowish, very granular and sparkling when fresh broken and a compact limestone which resembles the Birdseye limestone."[3] These constitute the F u c o i d a l l a y e r s. The latter rock is more fully described as follows: "These layers are . . . readily distinguished from the calciferous rock by their disposition in thick strata, many parts of which when long exposed show a structure as if formed of numerous thin ones. The mineral composition is more varied, showing frequently a mixture of Calciferous sandrock and Birdseye limestone . . . It often presents ramose forms usually composed of the Calciferous portion (p. 35). The peculiar mode of weathering of this rock is also mentioned by Emmons.[4]

In the *13th annual report of the state geologist* (1893) five pages are devoted to the consideration of the Calciferous formation in the

[1] *Loc. cit.* Assembly doc. no. 161, p. 160.
[2] *Loc. cit.* Assembly doc. no. 200, p. 259.
[3] *Geology of New York*, pt 3, p.30.
[4] *Geology of New York*, pt 2, p. 105; see also *Agriculture of New York*, 1846, 1:119.

Mohawk valley (p. 417-22). The formation is said to have a thickness of "200 to 250 feet on the Mohawk" (p. 418). It is also stated that "the fucoidal layers are near the summit of the formation." Speaking more in detail of this member of the Calciferous the author Mr Darton says "The fucoidal layers of Vanuxem are a characteristic member of the Calciferous over a wide area. They are well exposed in many of the quarries along the Mohawk, where they are worked extensively for building stone. . . The member consists of a fine grained, thick bedded limestone intermediate in character between the typical Calciferous and Birdseye deposits with intercalated streakings, blotchings, reticulations and sprinklings or mixtures of coarse sand and Calciferous materials of light color in greater part but weathering dark. The alternations are in thin layers at varying but frequent intervals, and the bedding of the fine grained material is usually more or less disjointed into a partial breccia. The coarse materials are disposed in forms suggesting fucoids, and this resemblance has given the name to the member. Fossils are usually present and constitute a limited but characteristic fauna. This member appears to have a thickness of about 15 feet in the Mohawk valley" (p. 420, 421).

Birdseye limestone. The name "birdseye" or "birdseye marble" was a popular designation of limestone containing cylindrical tubes which in cross section on the polished surface bore a fancied resemblance to birdseye maple. Prof. Eaton uses the term in its popular sense in the following mention of the rock now known as Birdseye, "when it [metalliferous limerock=Trenton] is compact and contains numerous stylastrites, as on East Canada creek it may be wrought into a beautiful variety called birdseye marble.[1]" In the *Geological nomenclature of North America* birdseye marble becomes a designation of the subdivision of the metalliferous limerock (Trenton) in which "the natural layers are pierced transversely with cylindrical petrifactions so as to give the birdseye appearance when polished" (p. 13). In another place he speaks of these vertical tubes as "vertical encrinites" (p. 23).

In the *First annual report on the geological survey of the third district* (1837) by Mr Conrad, the Birdseye limestone is called "gray sparry limestone of the Mohawk valley." Its thickness is given as 30 feet at Littlefalls and it is said to thin out and disappear to the east along

[1]Geological and agricultural survey, district adjoining Erie canal, p. 32.

the canal. Amsterdam is among the localities at which the rock was noticed.[1]

In the second report Mr Vanuxem mentions the fossil Fucoides demissa (Stylastrites of Eaton) as characterizing the Birdseye and names among the localities of the rock "Amsterdam on both sides of the river near Evakill, Marcellus quarry [Rockton] between the kill and Chucteronde creek [Chuctanunda of the present report];"[2] and again, "this rock contains fragments of the Calciferous at Marcellus quarry near Amsterdam" (p. 283).

In Vanuxem's final report a full account of this rock is given with a woodcut exhibiting the fossil Fucoides demissa (=Phytopsis tubulosa, Hall). He says "the Birdseye limestone of the Mohawk is readily distinguished from the other rocks by its light dove-color, which by long exposure to the weather becomes of a light ash gray or white. It is usually in thick layers which are straight, having very little interposed matter between them, with vertical joints which are so straight and even as to give to the rock where quarried the appearance of a wall. In its grain it is very compact, fracture smooth, and from being brittle, is an easy rock to work."[3] Among the localities mentioned for the Birdseye are a "small quarry back of Amsterdam" where "the layers are few in number and of no great thickness" and "in two insulated hills between the [Marcellus] quarry and Chucteronde creek" (p. 41).

Emmons in his final report of 1842 figured the fossil Fucoides demissa considering it as an animal of the class of Polypes, and also figured and described a peculiar anastomosis sometimes seen on the surfaces of layers of Birdseye.[4] In his volume on agriculture he states that the Orthoceras multicameratum is equally characteristic with Fucoides demissa.[5]

In Darton's paper on the *Geology of the Mohawk valley* (1893) the Birdseye is described as a white-weathering rock containing fucoid stems and represented about Amsterdam by "from 3 to 5 feet of very compact, gray to black, thin bedded limestone

[1] *Loc. cit.* Assembly doc. no. 161, p. 162, 163.
[2] *Loc. cit.* Assembly doc. no. 200, p. 259.
[3] Geology of New York, pt 3, p. 38.
[4] Geology of New York, pt 2, p. 109, 110.
[5] Agriculture of New York, 1:122.

with very rare birdseyes" sharply separated from the underlying Calciferous.[1]

Black river limestone. In the earlier works on New York geology the Black river limestone was either not separated from the succeeding mass or was confused with other rocks. In the final report on the first district (1843) Mather gives the following synonomy of the Black river limestone: "Mohawk limestone, Birdseye limestone, base of the Trenton limestone, Bald mountain limestone, Blue limestone, Chazy limestone, Black marble of Isle la Motte, Seven foot tier, and perhaps the Neeleytown limestone, of the geological reports of New York, Metalliferous limerock, Transition chequered and sparry limerocks of Eaton, No. 2 of the Pennsylvania survey."[2]

In the final report of Vanuxem the Black river limestone is clearly distinguished and described at its type locality, Black river in Jefferson county. The description is in part as follows:

The cliff which forms the western margin of this river consists generally of a limestone in thick layers, the upper ones unusually thick. . . The mineral character is generally the same with the Birdseye, specially the layers below the upper surface one, being rather brittle and breaking with a smooth and flat conchoidal surface. . . The upper part is intermixed irregularly with black shale and exhibits the characters and position of the mass intermediate to the Birdseye and the Trenton limestone of the Mohawk which position it also holds. . . The large and handsome chambered Columnaria sulcata [Columnaria alveolata Goldfuss], the same which is found in the thick layers resting upon the Birdseye at Tribeshill, etc. is often seen in the exposed surface of this rock.[3]

In reference to the rock having the stratigraphic position of the Black river limestone in the Mohawk valley he says:

On the Mohawk there are several quarries opened in a mass of limestone which rests upon the Birdseye as may be seen in three of them, and in two of which it is followed by the well characterized Trenton limestone. This mass therefore holds the same position as the upper division of the Black river limestone and contains some of the same fossils, but the mineral character is different, resembling more the gray limestone of the upper mass of the Trenton limestone. These quarries are Stanton's on the south side of the Mohawk about

[1] 13th annual report N. Y. state geologist, 1893, p. 422, 423.
[2] Geology of New York, pt 1, p. 402.
[3] Geology of New York, pt 3, p. 42.

a mile below Amsterdam. . . Some of the layers at Amsterdam are referable to this mass as well as a large portion of the rock quarried at Schelpintown [Rockton]. In all these localities the color of the rock is gray, lighter or darker in some than in others, has a crystalline grain, rather tough. . . Some portions contain knobs, the result of accretionary action (p. 43).

Then follows a detailed description of the "rock at Stanton's quarry" (p. 44).

In the final report of Emmons the Black river limestone receives the name of "Black marble of the Isle la Motte" and is characterized as the mass between the Birdseye and Trenton limestones, separated into several layers and having a total thickness of about 12 feet. It is often known as the Seven foot tier and is often lumpy. The fossil Columnaria sulcata is said to be quite abundant at Watertown, Glens Falls and Chazy.[1] In the volume on agriculture the designation of this rock is "Isle la Motte marble," and its thickness is given as "25 or 30 feet" at Isle la Motte and "7 or 8" at Watertown where it is said to be lumpy.[2]

Mr Darton makes very little mention of the Black river limestone but states that:

In a small area near Amsterdam and in the Glens Falls region the Black river beds appear to be represented together with a heavily bedded member at the base of the Trenton. In a small stream emptying into the Mohawk opposite Amsterdam there is a three foot bed of coarse limestone of dark gray color containing corals, including Columnaria alveolata which I believe represents the Black river horizon.[3]

Trenton limestone. Prof. Eaton in 1824 described this rock mass under the name of "metalliferous limerock" as a compact, gray, sometimes slaty, frequently cellular rock containing calcareous spar in scales and abundant fossils.[4] The region under consideration is mentioned among the localities of rock (p. 81).

In the *First annual report on the geological survey of the third district* the Trenton is called "Blue fetid limestones and shales of Trenton falls" with a thickness of about 400 feet. It is evident that part at least of the present Utica formation is included under the

[1]Geology of New York, pt 2, p. 110, 111.
[2]Agriculture of New York, 1:123.
[3]13th annual report N. Y. state geologist, 1893, p. 424.
[4]Geological and agricultural survey district adjoining Erie canal, 1824, p. 33.

above designation. Three miles north of Amsterdam it is said to be "quite pure, compact and durable."[1]

In the *Second annual report* by Vanuxem the Trenton is definitely spoken of as "Trenton limestone" with the statement that "South of the Mohawk the Trenton limestone both in Herkimer and Montgomery counties rarely exceeds a thickness of 10 feet nor much beyond that thickness in any part of the latter county."[2] The faunal character of the rock is stated as follows:

> This limestone is readily distinguished from all the other rocks by the numerous individuals of the Leptaena alternata [Rafinesquina alternata (Con.) Hall and Clarke], Delthyris striatula [Orthis (Dalmanella) testudinaria Dal.?], Orthoceras striatum, Bellerophon apertus, Favosites ——, Calymene blumenbachii [C. callicephala Green], Cryptolithus tessellatus [Trinucleus concentricus Eaton], Isotelus gigas [Asaphus platycephalus Stokes] and cyclops [same as preceding] (p. 283).

In the *Fourth annual report* Vanuxem says that on the Mohawk river the Trenton is in no place 30 feet in thickness,[3] but again "On the Mohawk its thickness rarely exceeds 30 feet" (p. 371). In his final report this statement is repeated with the addition that "it is not so thick at the east as at the west end."[4] Here also he says that "the gray variety of limestone does not appear upon the Mohawk."

In Mather's reports the occurrence of the Trenton in Schenectady county near Amsterdam is several times mentioned specially in the final report,[5] and in this report a section is given made by Cadet T. Seymour at "Marlit & Denham's quarries, near Hoffman ferry" which foots up 20 feet, 10 inches (p. 400). This may be the Weatherwax quarries of the present paper.

In the *13th annual report* (1893) the Trenton is said to comprise three principal members, a "thick bedded, coarse grained, light colored crinoidal limestone. . . underlaid by a series of thin bedded, dark limestones, with more or less intercalated black shale. . . . Then there is a very massive, dark, coarse limestone which begins as a basal series near the Mohawk in the eastern

[1] *Loc. cit.* Assembly doc. no. 161, p. 163, 164.
[2] *Loc. cit.* Assembly doc. no. 200, p. 275.
[3] *Loc. cit.* Assembly doc. no. 50, p. 365.
[4] Geology of New York, pt 3, p. 49.
[5] Geology of New York, pt 1, p. 397, 398.

part of Montgomery county and extends to the southeastward, coming out in great force at Glens Falls where it is extensively quarried for black marble. . . The lower massive series appears to be an older member of the formation overlapped westward and apparently to some extent near its southern termination by the thin bedded series."[1] This massive series is developed "in the region about Amsterdam and eastward to the Hoffman ferry fault. . . becoming somewhat thicker and coarser grained in the easternmost exposure. In the quarries and stream cuts north of Amsterdam there are exposed 17 feet of the coarse grained massive series, here rather thinner bedded than usual. At the extensive quarries [Weatherwax] two miles northwest of Hoffman ferry the lower member is very coarse grained, soft, massive bedded, highly fossiliferous limestone and has a thickness of about 20 feet" (p. 426).

Utica shale. This mass is included with the Transition Graywacke of Eaton as in part at least the slaty variety.[2] Mr Conrad included the Utica in part with the Trenton, for he says "the rock is chiefly a fissile slate, but as it passes north it assumes as at Trenton Falls the character of a dark blue, very hard fetid limestone. . . The slate is frequently traversed by veins of calcareous spar."[3]

Vanuxem first spoke of the Utica as the black shale which appears from under the rubblestone (Hudson river) and extends from east to west throughout the county (Montgomery).[4]

Mather calls the Utica the Mohawk slate group and says that it "passes into the Trenton by gradual interstratification."[5]

In the *Fourth annual report of the third district* Vanuxem says "there is no mineralogical difference between the shale which separates the dark colored layers of the Trenton limestone and this rock, but though in many localities it contains thin beds or flags of limestone in the lowest part of its mass, yet we often find above these thin beds a thickness of two or more hundred feet without any limestone whatever."[6]

In Vanuxem's final report this rock is designated "Utica slate," and is described as "of a deep bluish black, generally fissile, ex-

[1] 13th annual report N. Y. state geologist, 1893, p. 424, 425.
[2] Geological survey district adjoining Erie canal, p. 91.
[3] First annual report third district (N. Y.) Assembly doc. no. 161, p. 163.
[4] Second annual report third district, Assembly doc. no. 200, p. 258. *See also* p. 283.
[5] Fifth annual report first district, Assembly doc. no. 150, p. 91, 92.
[6] *Loc. cit.* Assembly doc. no. 50, p. 371.

hibiting a brownish or dark chocolate color by alteration or long exposure to the weather. . . It is associated with thin beds of the same kind of colored impure limestone which are usually found in the lower part of the mass. . . . The slate often presents thin veins of white lamellar carbonate of lime. . . [It has] a thickness whose maximum is about 250 feet."[1]

Of this mass Emmons says, "It would do no violence to geological classification to incorporate it with the Trenton limestone below or with the Lorraine shales above"; however, "this mass is well developed in the valley of the Mohawk."[2]

In Mr Darton's paper it is stated that "Its Utica characters are quite unmistakable throughout the Mohawk valley. They are very dark, even bedded slates and shales, with alternating slabby beds at most localities."[3]

The following estimates of the thickness of the Utica formation are given because of their bearing on the estimates which will be given in a later part of the present paper, though some of them do not apply to this region. Vanuxem's estimate of 250 feet in Montgomery county has already been quoted. In a summary of the thickness of the formations of the "Champlain division" Emmons estimates the Utica shale at 100 feet,[4] and in another place he says "The slate [Utica] in the gorges of Lorraine and Rodman is about 75 feet thick; it is at least less than 100 feet."[5] Dana gives the thickness of the Utica formation as 250 feet in Montgomery county.[6] Other estimates are those of Mr C. D. Walcott and Prof. C. S. Prosser, derived mainly from well records. Walcott gives the thickness of Utica passed through in the Campbell well near Utica as 710 feet,[7] and in a diagram in the latter paper indicates that the formation thickens eastward (p. 350, *diag.*). In his section along the south branch of Sandy creek in Jefferson county Walcott gave 180 feet of Utica shale with 100 feet of transitional beds composed of "alternating bands of shale and gray, fine grained, calcareous sandstone, the shale predominating" (p. 348 and *diag.* p. 350). Prosser gave the thickness of the Utica shale in the

[1]Geology of New York, pt 3, p. 56.
[2]Agriculture of New York, 1:123, 124.
[3]13th annual report N. Y. state geologist, 1893, p. 429.
[4]Agriculture of New York, 1:127.
[5]Geology of New York, pt 2, p. 118.
[6]Manual of geology, ed. 4, p. 494.
[7]Am. ass'n adv. sci. proc. 35:212; also Geol. soc. Amer. bul. 1890, 1:347.

Chittenango well, 32 miles west of Utica, as 233 feet, below which are 60 feet of transitional shale and limestone. In this well are 640 feet of blue argillaceous shale and sandstone referred to the Hudson (4 :99). In the Rochester well the thickness of the Hudson and Utica together is given as 598 feet.[1] In the Altamont well about 17 miles west of Albany the drill started 595 feet below the base of the Helderberg limestone which caps the Hudson river formation in that vicinity, and passed through 2880 feet of sandstone and shales before reaching the Trenton limestone.[2] Mr Henry M. Ami says, "By some of the early writers it [Utica formation] was spoken of as consisting of shaly strata whose total thickness exceeded 900 feet, whilst by others the very humble yet perhaps truer estimate was given 'of about 75 feet in thickness.'"[3]

Hudson river shale. This rock is the Second Graywacke of Eaton which is well developed in the vicinity of Schenectady and in large areas of the state.[4] Mr Conrad named the terrane from its western exposures the "Gray sandstones and shales of Salmon river."[5] In the *Second report of the third district* Vanuxem states that the rock appears "as a dark coloured sandstone in Montgomery [county], with but little shale."[6] In the *Fourth annual report of the first district* (1840) Mather uses the term "Hudson river slate group" which he says consists of "slates, shales and grits with interstratified limestones."[7]

In the same year Vanuxem described under the name of Frankfort slate "the rock or mass [which] is the successor to the black slate, the one changing to the other by imperceptible gradations, the dark or black color of the lower rock disappearing in the lighter color of the upper rock."[8] He also substituted the term Pulaski shales for the shales of Salmon river and added the term Salmon river sandstones for the arenaceous rock above the Pulaski shales (p. 374).

In his final report Vanuxem clearly states the distinction between the Utica and Hudson river (Frankfort) shales. "The Utica," he

[1]Rochester acad. sci. *proc.* 2:92.
[2]Ashburner Am. inst. min. eng. *trans.* 16:951, 952.
[3]Reprint from Can. rec. sci. Oct. 1892, p. 3.
[4]Geological and agricultural survey district adjoining Erie canal, 1824, p. 85.
[5]First annual report third district, Assembly doc. no. 16, p. 164.
[6]*Loc. cit.* Assembly doc. no. 200, p. 257.
[7]*Loc. cit.* Assembly doc. no. 50, p. 212.
[8]Fourth annual report third district Assembly doc. no. 50, p. 372.

says, "alternates at its lower part with thin beds of dark colored impure limestone and is connected by alternation and by organic remains with the Trenton limestone. . . The Frankfort slate on the contrary alternates with a peculiar sandstone to which Prof. Eaton gave the name of rubblestone. The slate is wholly destitute of calcareous particles and its great thickness in the first district, though it diminishes going west and north, entitles it to a distinct appelation."[1]

In the final report of Emmons the name "Lorraine shales" is used as the designation of this terrane.[2] In the *Report on agriculture*, Emmons gives the thickness of this formation at the northern termination of the Helderberg range where he says "it probably forms the thickest mass of any other locality in the state" as "not less than 700 feet" (p. 125). This is also the estimate given by Dana.[3]

In Hall's final report it is stated that "where the strata are undisturbed a well marked line of division usually separates this group [Hudson river] from the Utica slate."[4] Here the name Hudson river group is used as is also the case in the final report of Mather, the latter designation appearing in place of Hudson river slate group (pt 1, p. 367).

C. D. Walcott says, "In many instances it is difficult to indicate the line of demarcation between the latter [Utica] formation and the strata above or below, while in other localities the limits of each formation are clearly defined."[5] In an address before the first Montreal meeting of the American association for the advancement of science, August 1857, Prof. James Hall said, "The Hudson river group presents us on the one hand with a series of soft shales becoming coarser and alternating with sandstones above, and on the other with irregular masses of limestone and finally immense masses of coarse sandstone or conglomerate with great bands of shale."[6] In an address before the Geological society of America (Dec. 27, 1889) Mr Walcott gave a historical sketch of the term Hudson river group and added the results of recent in-

[1]Geology of New York, pt 3, p. 61.
[2]Geology of New York, pt 2, p. 119.
[3]Manual of geology, ed. 4, p. 494.
[4]Geology of New York, pt 4, p. 30.
[5]Utica slate and related formations, Albany, 1879, p. 4.
[6]Contributions to the geology of the American continent, Salem, 1882, p. 41.

vestigation. In connection with a brief description of the Altamont well (already mentioned) he says, "If the geologist follows along the contact of the Hudson series with the Lower Helderberg to the Schoharie kill and then proceeds down stream to the valley of the Mohawk he will pass over a large portion of the section penetrated by the well, and in the valley of the Mohawk find that the series rests conformably upon the Trenton limestone, and that the base is formed of dark Utica shales."[1]

Topography

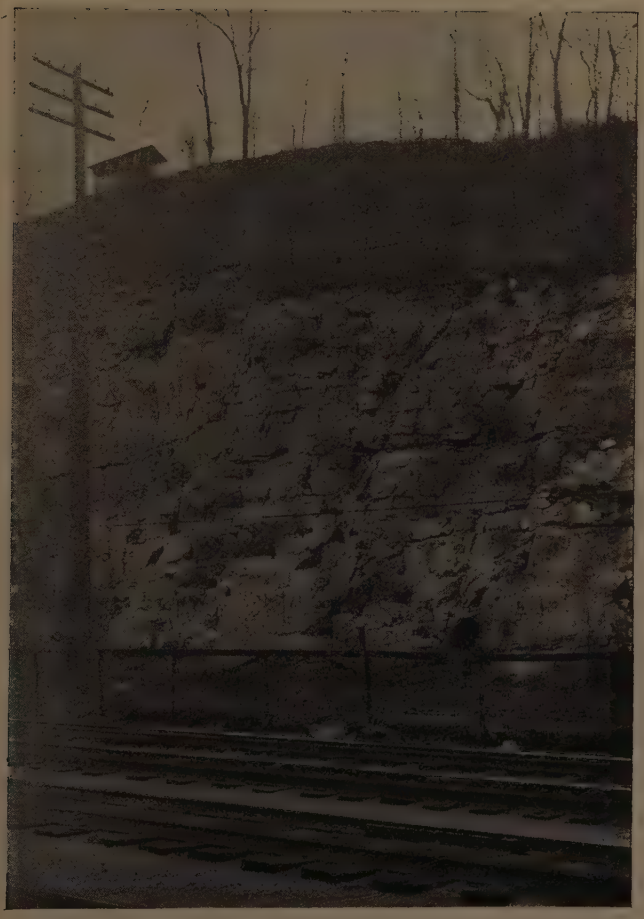
Topographically the area under consideration may be divided into three regions accurately corresponding to as many types of geologic formations. These regions are 1) the limestone region comprising all the area of the outcrop of the Calciferous-Trenton formations; 2) the region of the outcrop of the Utica shale and 3) the region of the outcrop of the Hudson river shales and sandstones. Besides these there are slight modifications of the typical topography of these formations due to glacial drift.

The first region, that of limestone, is characterized by a low rolling relief and shallow stream valleys, except where the streams have been forced to cut new courses through morainic material or because of the obstruction offered by such material have been turned aside to make new rock cuts. The latter is probably the case with the lower courses at least of the North Chuctanunda and Evakill, for while they are at present making rock cuts their banks show deep cuts through boulder clay and their beds are in no respect those of mature streams, both from the abundance of waterfalls and the irregularity of their slope. The northwestern portion of this region is heavily covered with drift and the topography is more angular on this account.

Along the eastern border of the limestone belt the topographic features are determined by the presence of the Hoffman ferry fault, and along most of this line there is a distinct escarpment as described in another part of the present paper. At its northern end this escarpment is dissected, leaving only a number of isolated hills with their longer axes in a northeast-southwest direction. The southern end however stands out in a bold cliff just back of Hoff-

[1]Geol. soc. Amer. bul. Ap. 1890, 1:346.

Plate 1



Railroad cut in Calciferous sandstone at Hoffmans

man station. South of the Mohawk the Calciferous sandstone appears in low ledges along the greater part of its outcrop. The Trenton limestone produces a gentle topography with scarcely any ledges or sharp lines.

The second region, that of the Utica shale, is characterized by rounded hills rising at their maximum to an altitude of 1062 feet A.T. or about 800 feet above the Mohawk river. Here again there are no deep glens. The formation is very homogeneous, there being few hard layers to form waterfalls or steep slopes by the more rapid disintegration of underlying shale. The highest parts of this region are near the parting of the Utica and Hudson river shales. After the removal of the latter formation the Utica shales are rapidly reduced to base level.

The third region, that of the Hudson river formation, furnishes by far the most interesting topography, being characterized by bold relief; the very soft shales interstratified with firm layers of sandstone produce an abundance of deep and very narrow glens and steep hillsides. Waterstreet hill back of Rotterdam Junction rises to an altitude of 1400 feet A.T., nearly 1000 feet above the level of the Mohawk river. Its northern slope is steep and with the southern slope of the Glenville hills across the river forms the Notch, so conspicuous a feature of the northwestern horizon from the vicinity of Schenectady 10 miles to the east. Eastward the hill plunges abruptly to the bed of the Plotterkill, forming one of the finest glens in the eastern part of the state. The streams emptying into the Mohawk in Rotterdam township form a series of beautiful and characteristic waterfalls. Almost every heavy sandstone layer has its fall. Normankill in the southern part of this region flows for the greater part of its course in a deep narrow valley often amounting to a gorge with precipitous sides. This stream, it will be noted, empties into the Hudson river near Albany. The divide between the Mohawk and Normankill drainage reaches an altitude of over 1400 feet A.T. and extends with little variations from this amount through Rotterdam, Princetown and Duanesburg townships. It will be seen that Mariaville pond and Featherstonaugh lake are situated only 100 feet below the summit of the divide which is less than half a mile south of the latter.

The hills of these Hudson river strata rise abruptly along the Hudson-Utica parting. The valley of South Chuctanunda rapidly

narrows on reaching this line but expands again into a swampy tract which has probably been caused by glacial damming of its headwaters. The same explanation of the Mariaville pond and Featherstonaugh lake is offered. To the east the Poentickill heads within a quarter of a mile of the Plotterkill which stream it must eventually tap.

The peculiar basin shape of the upper valley of the Sandseakill very strongly suggests that this stream had matured before the coming of the ice sheet during that period and that its lower course has subsequently been cut through glacial debris and has not yet affected the gradient of the upper valley. The presence of large amounts of till throughout the lower course which has nowhere reached the rock tends to substantiate this interpretation of the topography.

Stratigraphy

North side of Mohawk. In order that the areal distribution of the formations to be described in the present paper may be considered along with the more detailed description of particular sections, the order of treatment of the latter will be determined by their geographic distribution beginning with the most westerly on the north side of the Mohawk river.

Just west of the highway bridge across the Mohawk river at Amsterdam is an excellent exposure in the north bank of the river of the lower members of the Trenton stage. This point is immediately beneath the yard of a large brick dwelling house that stands near the river bank. The following layers are exposed.

45A[a] **Section just west of Amsterdam highway bridge**

A[9]	Level of yard. Massive crystalline limestone, dark to grayish blue, weathering gray. Highly fossiliferous. Abounding in Rafinesquina alternata (Con.) Hall and Clarke. Trenton.	8′=14′ 10″
A[8]	Irregular dark drab layer.	6″= 6′ 10″
A[7]	Light to dark drab of irregular lumpy structure.	9″= 6′ 4″

[a] The system of recording localities employed by the department of geology of Union university was as follows: when a new locality is visited it is given a station number, as 45 in the present case, which number indicates the order in which the locality was first studied. Thus Amsterdam was the 45th locality visited under the present system. The sections studied in any given locality are each given a letter, as A in the present case, in the order of their study, and the various divisions of the section are numbered in the ascending order by primes, as A[1], A[2], etc.

A^6 Massive or weathering to thin irregular layers. Dark drab; contains corals (Streptelasma).	2′	= 5′ 7″
A^5 Thin distinct layers at base but seeming to coalesce above into thicker layers; dark drab.	1′ 10″	= 3′ 7″
A^4 Grayish blue, very smooth, compact limestone.	6″	= 1′ 9″
A^3 Thin layers of light drab blue limestone.	6″	= 1′ 3″
A^2 Compact drab blue with smooth joint faces. Birdseye.	9″	= 9″
A^1 Thin layers of arenaceous limestone to river level. Calciferous.		

The above section affords an excellent opportunity to study the lithologic characters, color and weathering of the lower divisions of the Trenton stage. The layers are under water at the flooding of the Mohawk river and are thus freed from soil stains so that they clearly show the normal weathering of the rock. The difference in color between the massive Trenton and Black river and Birdseye beds (A^{2-8}) is very conspicuous and the line between the Black river and Trenton is sharp. The line between the Black river and Birdseye substages is not so distinct but may probably be drawn at the top of A^2. The Birdseye is very variable in thickness throughout this region.

Above the section just described the Trenton limestone is exposed at several places in the lower part of Amsterdam west of the Chuctanunda creek, and specially in the northwestern part of the city at an altitude of 90 feet above river level. The layers exposed at the latter point are highly fossiliferous and dip strongly to the south and west. They belong to the lower part of the Trenton substage. Along Spring street in the western part of the city the Trenton thins out, and at one or two points the Calciferous is again exposed. At the head of one of the streets crossing Spring street about a mile west of the Chuctanunda is a small quarry recently opened. In this quarry a three foot layer of Birdseye limestone of excellent quality for construction stone is worked. The stratum of Birdseye rests on very arenaceous limestone and is capped by a few feet of extremely lumpy, black, somewhat fossiliferous limestone. Not far west of this point the Calciferous is again exposed and extends up the bed of the creek half way between

Amsterdam and Aiken to the first branch of the creek, where the Trenton limestones are again exposed and may be traced to the forks of the creek. The higher part of the city of Amsterdam is mainly composed of clay, and no rock is exposed higher than 90 feet above the river except along Chuctanunda creek and its branches.

North Chuctanunda creek, as it is called on the Amsterdam topographic sheet, has its head waters in Perth and Galway townships and after pursuing a southwesterly course empties into the Mohawk river just west of the present Amsterdam railroad station. From Hagaman's mills to its mouth the stream flows over a large number of low escarpments formed by the unequal erosion of the limestones which compose its bed, and almost every one of these waterfalls has been utilized for water power. Thus for a distance of several miles the water of the little stream is handed from one mill to another. Near the Sanford carpet mill the main creek receives a branch from the north. This branch rises by several head branches in the township of Perth and pursues an almost due south course. The most eastern of these head branches receives the water of the Amsterdam city supply system from the Amsterdam reservoir pipe line (the reservoir itself being in Galway) at a point near the Fulton-Montgomery county line, and the city water thus flows together with the water of the creek into the secondary reservoir just southwest of Rockton. Both branches of the Chuctanunda are of considerable geologic interest.

Near the mouth of the Chuctanunda just below the depot the upper layers of the Calciferous sandrock are exposed as follows (45C):

C^4 Shaly, fucoidal, thin bedded layers weathering ash-white. This rock is in general composed of a matrix of rather pure limestone, with fucoid-like fillings composed of arenaceous material which gives the weathered surface a mottled or reticulated appearance. 7′=23′

C^3 Grayish blue mottled fossiliferous layer to some extent resembling the compact mottled layers sometimes seen in the Trenton limestone but more arenaceous. Specimens of Ophileta are fairly abundant. 1′=16′

C^2 Massive, arenaceous irregularly jointed fucoidal limestone weathering light gray. 11′=15′

C[1] Covered with soil and debris to river level.

From no. 3 of this section good specimens of Ophileta complanata Van. were obtained in considerable numbers and also a few specimens of Lingula (Glossina) acuminata Con.? and several well preserved specimens of two small lamellibranchs. The layers of this section correspond closely in stratigraphic position to those exposed in the mouth of Chuctanunda creek. Calciferous sandrock is exposed in the bed of the creek to the gorge above Sandford's carpet mill. Just north of the dam at Sandford's mill are 4½ feet of thick bedded, grayish, fossiliferous limestone weathering lighter gray. The base of the exposure is 10 feet above the Calciferous sandrock exposed in the creek bed below the dam. Near the large warehouse on Willow street are 6½ feet of dark blue, light-weathering limestone containing corals and Rafinesquina alternata (Con.) Hall and Clarke. On the upper surface of this exposure is a beautiful exhibition of glacial striae. The striae run N70°W. The rocks at this point dip about 3° S, 24° W. Following the branch of the creek from this point the Calciferous sandrock is again exposed in the creek bed, the layers being in the main thinner than those farther down stream. At approximately 60 feet above the exposures at Sanford's mill the course of the creek becomes more easterly, and on the north side of the creek at this point there is a quarry in Trenton limestone in which the basal layers are massive, thick bedded and aggregate about 10½ feet in thickness, while the upper layers are thin, irregular and somewhat distorted and also aggregate about 10½ feet in thickness. The dip here is 4°N, 60°W. Where the course of the creek again becomes southerly the rocks are thin bedded, highly inclined and distorted and contain immense numbers of fossils. The creek flows in a trough formed by a small synclinal fold. These layers are separated by intercalations of black shale, specially noticeable in the highest layers. In the west bank of the creek at the dam of the reservoir just below the plank road were found loose fragments of Utica shale in such abundance as to suggest that they came from rock in place. Layers were not found however and it may be that the shale was placed there as ballast for the road, a supposition which would be perfectly in accord with methods of highway construction in this part of the country. All exposures of rock are cut off by the

reservoir, but above the pond thin, black, fine grained to coarse grained, richly fossiliferous layers of Trenton limestone are again exposed in the bed of the creek. The fossils Trinucleus concentricus Eaton, Monticulipora (Prasopora) lycoperdon Say and Rafinesquina alternata (Con.) Hall and Clarke are specially abundant. These layers belong to the very top of the Trenton substage and are typical of it. Opposite the northwestern part of Rockton the rock again disappears and is not exposed again till the Amsterdam water supply pipe-line is reached. Along this line are loose pieces of rock which were thrown out of the trench during the excavation and show by their sharp angles that they were blasted from rock in place. Near where the pipe-line crosses the Fulton-Montgomery county line is a small exposure of very fine grained, dove limestone containing bivalve crustacea, and of slightly coarser grained similar limestone containing corals (Streptelasma). This rock, therefore, belongs to the Birdseye and probably Black river substages. Fragments of similar rock occur along the pipe-line to near the branch of Chuctanunda creek northwest of Hagaman. Heavy bedded arenaceous limestone is exposed in the bed of this creek. Northwest of Hagaman and just north of the Fulton-Montgomery county line is a farm house standing well back from the road, and known as the "Old Bunn place." The rock here is for the most part typical Calciferous but some of the upper layers are of a rather peculiar character. On fresh fracture they closely resemble Birdseye limestone, but the weathered surface shows knobs and reticulations composed of arenaceous material weathered dull yellow. The matrix weathers nearly white. Similar rock clearly referable by its stratigraphic position in connection with its lithologic characters to the fucoidal member of the Calciferous stage may be seen below the quarry back of Crane's village,[1] in the ledges along the West Shore railroad opposite Crane's village and in the river bank below the Amsterdam depot and at Pattersonville.

Along the valley of the Chuctanunda between Sanford's mill and Rockton are several fine exposures of the Trenton stage. In the small gorge below the large pond east of Sanford's there is an

[1]This place is called Cranesville on the U. S. geological survey Amsterdam topographic sheet but is known locally as Crane's village and is so on the N. Y. C. & H. R. railroad time cards.

exposure of 5 feet of Birdseye limestone resting on an irregular surface of arenaceous Calciferous sandrock and covered by a foot or two of thin very lumpy black limestone, which is in turn succeeded by more compact semi-crystalline limestone. The sharp break between the Birdseye limestone and Calciferous at this point is mentioned by Darton, as also the dip, which is very noticeable.[1] At the foot of the next small pond is a fine exposure of nearly the entire Trenton stage.

45F **Section at Smealee's paper mill**

F[6] Thin bedded, dark colored, richly fossiliferous limestone becoming shaly in the upper layers and covered by a thin layer of soil. These layers are somewhat crushed and folded. Base of this division forms the floor of the quarry. Trenton.	18′=43′ 4″
F[5] Medium to thin bedded dark blue fossiliferous limestone abounding in brachiopoda. Trenton.	10′=25′ 4″
F[4] Heavy bedded dark blue coarse to fine grained limestone weathering light gray with rough lumpy surface. Contains corals. Black river in part.	10′ 4″=15′ 4″
F[3] Three layers, two thin and one thick, dark drab to bluish, fine grained to coarser at top, smooth vertical cleavage, weathering ash-white. Separated from no. 2 by a thin layer of shale. Somewhat pyritiferous. Birdseye limestone.	2′ 3″= 5′
F[2] Two layers of fine grained drab limestone weathering very light bluish gray. Lower layer with smooth weathered surface, upper rough. Somewhat pyritiferous.	2′ 9″= 2′ 9″

F[1] Arenaceous steel-gray limestone, irregular angular surface of brownish color, characteristically furrowed.[2] Calciferous sandrock.

This section may be compared with profit with the one almost exactly two miles due south at Morphy's. The measurements are strikingly alike and the differences in appearance are largely due to difference in the degree of weathering. Layers corresponding to

[1] 13th annual report N. Y. state geologist, p. 423.

[2] The upper surface of this rock wherever freely exposed to the weather is almost invariably furrowed so that it has a decidedly checked appearance.

the upper layers of the present section are worked in the quarry[1] extending a short distance farther up stream on its western side, for sills, a purpose to which they are well adapted by their thickness and grain. Many of the layers however are useless for the purpose owing to the numbers of fossils which they contain. Rock is exposed at many points between this place and Rockton where the creek has again cut through the entire Trenton stage. At the large quarries (Marcellus of Vanuxem[2]) just below Rockton the lower middle layers of the Trenton are worked and the quarry in the lowest layers has been abandoned. A section was measured beginning at the floor of the abandoned quarry.

45G **Section of Rockton quarries**

G^5 Extensively worked quarry. Medium thick bedded highly fossiliferous crystalline limestone nearly continuous with the upper layers of the lower quarry. Trenton.	10′=24′
G^4 Compact dark blue medium fine-grained limestone, containing sparkling crystals of calcite. Fairly abundant fossils. Trenton.	3′=14′ 4″
G^3 Medium fine grained dark and medium dark blue massive layers of limestone separated by thin shaly layers, weathering with ragged surface, studded with projecting corals (Streptelasma) and crinoid stems. Near the top a fine specimen of Columnaria alveolata Goldfuss occurs in place. Black river.	6′=11′ 4″
G^2 Slightly coarser than no. 1 with more of a blue tint. Contains crinoid segments. Weathers grayish blue with pitted surface. Black river.	1′ 4″=5′ 4″

[1]This is no doubt the Thomas J. Donlon quarry mentioned by Prof. J. C. Smock. He says, "On the west side of the stream [Chuctanunda] Thomas J. Donlon quarries limestone on the Vanderveer farm. . .The working face has a length of 500 feet, parallel with the creek and is 15 to 20 feet in hight. . .The beds are from two inches up to two feet thick, and the bedding surfaces are rather rough and uneven. The stone is blue limestone of Trenton epoch. *N. Y. state museum bul.* 3, Mar. 1888, p. 106.

[2]Second annual report third district, Assembly doc. no. 200, p. 283. This quarry is also described by Smock as follows: 'The quarry of D. C. & N. Hewitt is on the left side of the Chuctanunda creek and east of the Rock city road. At the south opening which was made many years ago the rock is a dense, blue limestone . . . it is the largest and deepest excavation here. The new quarries are about 20 rods northward and on the same side of the road.' A section of the quarry follows which foots up from 12 to 16 feet. *N. Y. state museum bul.* 3, Mar. 1888, p. 106, 107.

G[1] Massive, thick bedded, very fine grained, drab limestone with smooth nearly vertical joint faces. Weathers light bluish gray to ash-white. Fracture conchoidal. Birdseye limestone. 4″=4′

From no. 5 of the above section the following species were collected from the thin layers which are stripped from the upper part of the quarry.

1	Rafinesquina alternata (Con.) Hall and Clarke	(a)[1]
2	Orthis (Dinorthis) pectinella (Emm.)	(c)
3	Orthis (Dalmanella) testudinaria Dal.	(c)
4	Plectambonites sericea (Sowerby) Hall	(c)
5	Zygospira recurvirostra Hall	(r)
6	Rhynchotrema capax (Con.) Hall and Clarke?	(r)
7	Asaphus platycephalus Stokes	(r)
8	Leperditia fabulites (Con.)	(r)
9	Monticulipora (Prasopora) lycoperdon Say	(r)
10	Schizocrinus nodosus Hall	(a)
11	Stictopora acuta Hall	(r)

No. 1 of this section undoubtedly belongs to the Birdseye horizon, nos. 2 and 3 to the Black river and nos. 4 and 5 to the Trenton. The lower layers of the upper quarry can not be far above the upper layers of the lower quarry if they are at all above them. The specimens of Orthis pectinella found in the upper quarry are the clearest specimens of that species obtained from any exposures in this region and the species is also more abundant here than elsewhere. In fact I have not seen the species in abundance anywhere in the Mohawk valley except here and at the Cook quarry north of Littlefalls. Some of the specimens of Rafinesquina alternata are very gibbous and have the radiating striae subequal and the concentric striae prominent and crowded.

North of this quarry are many exposures of the Trenton stage about Rockton. Slightly northeast of Rockton the Trenton limestones disappear and the Calciferous comes out in force toward Hagaman.

In the eastern part of Amsterdam the Calciferous sandrock is exposed in the south slope of the hill below the cemetery at an altitude

[1]Relative abundance of species is indicated as follows: a, abundant; aa, very abundant; c, common; cc, very common; r, rare; rr, very rare, where only a single specimen is found.

of approximately 100 feet above river level. The rock here is somewhat thin bedded. A small quarry has been opened in medium thick layers of Calciferous in the side of the hill back of the streets about three quarters of a mile east of the depot, and the rock is rather dark blue and fine grained. Near the point where the highway crosses the small creek a short distance east of this quarry is a larger quarry in the same rock in the bed of the creek. Following the course of this creek northward the lower members of the Trenton stage are seen in the creek bed and banks at an altitude of about 220 feet above river level. Nearly due east from this point the lower beds of the Trenton are again exposed in the bank of the next creek east of the last mentioned creek, and at this point have been quarried to some extent. Certain portions of the rock are covered by a stalactitic incrustation.

Near the southern bank of the same creek just east of the highway which runs through Mannys Corners[1] is a small quarry in which the following section was measured (46B):

B^3 Thin bedded to shaly layers of limestone. Trenton.	1′ 6″=13′ 6″
B^2 Bluish gray, thick bedded limestone dividing into thinner layers on long exposed surfaces. Contains corals, brachiopods and crinoids. Trenton.	9′=12′
B^1 Massive, dark gray, thick bedded limestone abounding in corals (Streptelasma). Black river?	3′=3′

No. 1 may belong to the Black river horizon, but is not referred definitely to it inasmuch as the characteristic fossil (Columnaria) of that horizon was not found. Not far east of this quarry is a larger quarry in Trenton limestone of medium thin layers, dark blue, semi-crystalline and showing very black on the upper surfaces of the layers owing to the deposit of carbonaceous shale between successive deposits of calcareous material. Such a black film of carbonaceous material is often to be seen on the surface of layers of the Trenton limestone. About one half mile east by southeast of this point the Trenton limestones form the cap of an insulated hill or

[1]This place is given on some of the earlier state maps and atlases as Mannas Corners.

point which drops off abruptly to the east but has very little slope to the west. On the northeastern corner of this hill are extensive quarries and the place may well be called Quarry hill. A section was measured extending from the river level at Crane's village one mile south to the top of the hill.

46A **Section from Crane's village to the top of Quarry hill**

A[9] Thin bedded, dark blue limestone often of crystalline structure. Abounds in fossils including Asaphus platycephalus Stokes and Rafinesquina alternata (Con.) Hall and Clarke. Trenton. 5′=418′

A[8] Grayish blue limestone containing Columnaria alveolata Goldfuss and an abundance of crinoid segments. Near the top fragments of rock in all respects similar to Calciferous sandrock are imbedded in the limestone. Trenton. 1′ 6″=413′

A[7] Dark blue fine grained, lumpy, thick bedded limestone containing Columnaria alveolata. In the western part of the quarry the same layers become more crystalline in grain and grayish in color. Black river. 7′-9′=411½′

A[6] Dove colored limestone, fine grained with conchoidal fracture. In thin layers weathering somewhat unevenly. Birdseye. 2½′=402½′

A[5] Mostly covered but exposed at the top in the side of Quarry hill and in the floor of the eastern part of the quarry, and at the base in the highway near the Evakill.[1] Somewhat arenaceous limestone; less arenaceous at the top. 120′=400′

A[4] Medium to thin bedded shaly arenaceous limestone with fucoidal markings specially near the top where the color is dark blue and the weathering very light ash-gray. Contains iron pyrites. Base at level of Evakill. Fucoidal member of Calciferous. 130′=280′

[1]This creek is left without any name on the Amsterdam topographic sheet, but the creek which empties into the Mohawk at Crane's village is known as the Evakill.

A^3 Partly covered. Heavy bedded massive, very compact arenaceous limestone. Calciferous sandrock. 60′=150′

A^2 Covered with soil except at top. 60′= 90′

A^1 Covered. Gravel and boulders at the mouth of the Evakill. River level. 30′= 30′

The following species were identified from the Black river (Columnaria) zone:

1	Columnaria alveolata Goldfuss	(a)
2	Monticulipora (Prasopora) lycoperdon Say?	(r)
3	?Phytopsis cellulosua Hall	(a)
4	Streptelasma profundum Hall	(c)
5	Rafinesquina alternata (Con.) Hall and Clarke	(r)
6	Murchisonia bellicincta Hall	(r)
7	Crinoid segments	(c)

This section presents a number of points of interest. The upper part of no. 4 representing the fucoidal member of the Calciferous is of unusually dark color and weathers nearly white. It abounds in the so-called fucoidal markings. These layers are doubtless near the top of the Calciferous stage both from considerations of dip which would bring the Trenton due a few feet above them and from their lithologic character. The rocks on Quarry hill present several points of special interest. As one ascends the steep eastern slope of the hill a gradual transition in the lithologic character of the Calciferous sandrock, which is typical at the base of the hill, is noticed, the layers at the top being thin, finer grained, lumpy and less arenaceous. The weathered escarpment of Calciferous appearing at the southern end of the main escarpment of the hill does not look different superficially from the Black river and Birdseye beds which form the northern end of the escarpment. The Calciferous is however arenaceous and lighter colored. Above the Calciferous and forming as was stated the northern part of the escarpment or ledge (for the superincumbent rocks have been for the most part removed from the Calciferous at the southern part of the ledge) are layers belonging to the Birdseye and Black river horizons. The Birdseye at this point has a thickness of 2½ feet. Just over the edge of the hill in the northeastern part of the quarry the coral bearing lumpy layers of Black river limestone are seen resting immediately

on arenaceous rock (Calciferous) which forms the floor of the quarry at that point. Apparently the Birdseye limestone has thinned out entirely in a distance of two rods. In the western part of the quarry the Calciferous is not reached and the lowest layers exposed have the characters of Birdseye though there is here no sharp line between the Birdseye and Black river limestones. In the central part of the quarry there are apparently from 7 to 9 feet through which the Columnaria alveolata ranges. The rock at this point is compact and thick bedded. In the western part of the quarry the same layers are coarser grained and even more massive. In fact they resemble the lower massive member of the Trenton substage in lithologic characters, but their fauna as will be seen from the above list is characteristically Black river. No. 8 as seen in the western part of the quarry presents most peculiar characters. Portions of it are almost entirely made up of fragments and pebbles of brownish arenaceous rock quite similar to the Calciferous sandrock. The matrix is somewhat crystalline and contains a few small specimens of Columnaria alveolata which from their general appearance and association may be regarded as derived from the subjacent Black river beds in a manner similar to that in which the arenaceous pebbles were derived from the Calciferous sandrock. In some parts of the quarry, specially the southern part, the Black river limestone contains an abundance of iron pyrites and in some cases pockets lined with crystals of calcite. The upper surface of the rock at this point is striated, the striae running N 85° W. The dip of the strata in this quarry is about 2½° S, 20° W. Vanuxem mentions pebbles similar to the ones occurring in this quarry, at Tribeshill and about Amsterdam.[1]

The Trenton limestones are exposed at several points between Quarry hill and Mannys Corners, and both north and south of the highway one half mile east of Mannys Corners are small quarries in the Black river and Birdseye beds. In the exposure south of the highway are 8 feet of dark lumpy limestone and 1 foot of compact fine grained limestone at the base. North of the highway the Birdseye limestone is exposed and contains excellent examples of Phytopsis tubulosa Hall, with the surface reticulation mentioned by Emmons (pt. 2, p. 110).

Between Quarry hill and Van Epp's hill (the high hill just north-

[1]Geology of New York, pt 3, p. 44.

west of Hoffman ferry station) the Calciferous forms the surface rock and the superincumbent beds have been entirely eroded away. At Van Epp's hill however both the Trenton and the lower part of the Utica are present. A section from the level of the Mohawk river at Hoffman ferry to the top of Van Epp's hill is as follows, in ascending order.

2A **Section of Van Epp's hill**

A[1] Massive, thick bedded, steel-gray, arenaceous, buff-weathering limestone. The lower 20 feet covered beneath the railroad and 48 feet immediately succeeding, exposed in the N. Y. C. & H. R. railroad cut. Above cut mostly covered. Rock contains calcite and chert. Calciferous sandrock. 290′=290′

A[2] Base consisting of dark blue, moderately fine grained, arenaceous limestone containing fucoid-like markings which on weathered surface are yellowish in conspicuous contrast with the grayish-weathering matrix. Fucoidal member of the Calciferous sandrock. 60′=350′

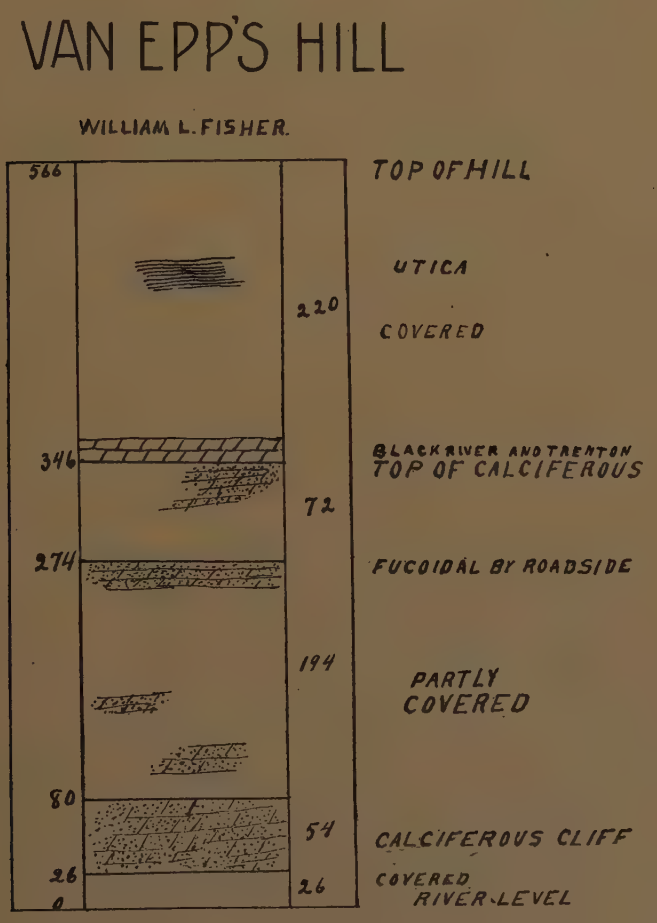
A[3] In open field east of highway at an elevation of 350 feet above river level, small exposure at spring, at top 3′ 11″ gray crystalline limestone (Trenton) underlaid by 2′ 6″ ash-white-weathering limestone (Black river), then 7″ gray crystalline limestone, finally 2½′ compact light-weathering limestone. Across the highway from this point are 5 feet in one layer of compact limestone containing Columnaria alveolata. Black river. 5′=355′

A[4] In the field west of the highway opposite a house are 5 feet of thick bedded blue crystalline limestone containing Rafinesquina alternata (Con.) Hall and Clarke, in abundance. Trenton. 5′=360′

A[5] In top of fault escarpment a short distance northeast of no. 4 are 25 feet of thin, fine grained layers of dark blue limestone containing Trinucleus concentricus Eaton. Trenton. 25′=385′

A^6 Black calcareous shale seen mainly in brown-weathered fragments in the slopes of the upper part of Van Epp's hill, and in a few places only is evidence of stratification preserved. Utica shale. 229′=614′

This section has been studied by several field parties from Union college and the measurements above given are for the most part the result of several careful surveys of the section. The



thickness of Calciferous is 350 feet measured in a nearly vertical line so that the error from dip is slight. As the gneiss does not appear in this region the total thickness of Calciferous here can not be ascertained. It is however much thicker than any previous estimates have indicated though probably not so thick as at

Sprakers, 25 miles to the west. Nos. 4 and 5 of this section are at some distance from each other but their lithologic and paleontologic characters clearly show them to belong to distinct parts of the Trenton substage. The layers of no. 5 are highly inclined but as their parallelism with reference to each other has not been destroyed the thickness given for them is fairly exact.

Northwest of Van Epp's hill the lower Trenton rocks are exposed near their junction with the Calciferous in a small quarry north of the highway between Glenville and Crane's village at a point not far west of the Schenectady-Montgomery county line. The layers here are as follows in descending order (2G):

G^7 At top very thin layer of granular highly fossiliferous rock adhering closely to next layer below.	
G^6 Drab, fine grained limestone with some crystals of calcite. Weathers ash-white. Contains fragments of a trilobite, probably Asaphus platycephalus Stokes, and crinoid segments on upper surface.	9″=5′ 9″
G^5 Two layers weathering ash-white, of drab color, fine grained. Contain corals (Streptelasma) and Gastropoda.	1′=5′
G^4 Thin lumpy layers of dark color, containing fragments of a trilobite.	8″=4′
G^3 Layer weathering very light gray, smooth fracture, very fine grain, drab. Contains Stictopora and Rafinesquina alternata (Con.) Hall and Clarke.	6″=3′ 4″
G^2 Light colored gray-weathering limestone with smooth fracture. Contains Orthoceras, Stictopora and fragments of a trilobite.	1′ 10″=2′ 10″
G^1 Thin bedded, dark blue, fine grained limestone showing occasional crystals of calcite. Irregular lumpy structure with slicken-sided masses. Weathers light gray. Contains Stictopora, corals and fragments of trilobite.	1′=1′

This entire section probably belongs to the Black river horizon though the characteristic fossil, Columnaria alveolata, was not found. The limits of the exposure are small.

East and north of this quarry the Trenton is exposed in the road toward Glenville. One half mile east of the Schenectady-Montgomery county line, some distance north of the highway between Glenville and Crane's village, is a quarry formerly extensively worked but now almost abandoned. A section was measured here with the following results (2D):

D^4 Coarse grained, dark blue, semi-crystalline limestone, layers seen in southern part of the quarry. Trenton. 1′=7′ 8″

D^3 Dark colored to drab fine to medium grained with numerous crystals of calcite. Contains Rafinesquina alternata (Con.) Hall and Clarke. 1′=6′ 8″

D^2 Lumpy, dark blue, fine grained limestone with occasional small sparkling crystals of calcite. Columnaria alveolata Goldfuss, occurs in place at the top of the northern part of the quarry, and at the base in the southern part. Black river. $3\frac{1}{2}$′=5′ 8″

D^1 Dove colored to grayish blue, very fine grained limestone with smooth fracture. No fossils. Birdseye. 2′ 2″=2′ 2″

The Calciferous sandrock is not reached in this quarry, so that the 2′ 2″ of Birdseye does not represent the whole of that formation. This is the farthest north of any clear section of the lower portion of the Trenton. The following species were collected in about an hour's search from the Black river limestone. No. 2.

1 Columnaria alveolata Goldfuss (c)
2 Streptelasma sp. (c)
3 Monticulipora (Prasopora) lycoperdon Say (r)
4 Stictopora cf. acuta Hall (r)
5 Stictopora elegantula Hall (r)
6 Stictopora cf. ramosa Hall (c)
7 Leperditia fabulites Con. (c)
8 Asaphus platycephalus Stokes (r)
9 Ceraurus pleurexanthemus Green (rr)
10 Rhynchotrema capax (Con.) Hall and Clarke (r)
11 Zygospira recurvirostra Hall (c)

12 Small gastropod, too imperfectly preserved for farther identification.

The junction between the Trenton and Calciferous stages is shown at the fault line to the northeast of this section. Where the Glenville road crosses the fault line are extensive quarries known as the Weatherwax quarries.

2E **Section of Weatherwax quarry**

E^3 Very thick, massive, dark blue crystalline limestone weathering grayish, and readily disintegrating. Contains Brachiopoda and Monticulipora (Prasopora) lycoperdon Say, in abundance. Trenton.	3′ 8″=14′ 4″
E^2 Layer similar to no. 3.	2′ 8″=10′ 8″
E^1 Layers exposed in the bottom of the quarry and ledge in side of road east of quarry. Thinner, fine grained, dark blue toward the base. About 8 feet in quarry and ledge.	8′= 8′

The exceptionally crystalline structure and great thickness of no. 2 and 3 are unique. They resemble to some extent the gray crystalline limestone which caps the Trenton formation at Trenton Falls but are darker and less crinoidal. The loose fragments of the rock about the quarry seem to disintegrate rapidly. They become spongy and the fossils they contain are rendered obscure. The following species were identified from no. 2 and 3 of this section:

1	Monticulipora (Prasopora) lycoperdon Say	(aa)
2	Bryozoan, probably Escharapora recta Hall	(r)
3	Protarea vetusta Hall	(r)
4	Rafinesquina alternata (Con.) Hall and Clarke	(aa)
5	Plectambonites sericea (Sowerby) Hall	(c)
6	Orthis (Dinorthis) pectinella (Emm.) Hall	(c)

Southward from this point these upper massive layers may be traced for some distance along the fault line. Near the point where the Chuctanunda creek meets the fault line there is an exposure of nearly 30 feet of thin bedded, dark blue, fossiliferous limestone with some intercalations of black shale and containing immense

numbers of Trinucleus concentricus Eaton. The following species were obtained in about an hour's search (2F):

1	Escharapora recta Hall	(r)
2	Monticulipora (Prasopora) lycoperdon Say	(r)
3	Lingula quadrata Eichwald	(r)
4	Orthis (Dalmanella) testudinaria Dal.	(a)
5	Rafinesquina alternata (Con.) Hall and Clarke	(c)
6	Plectambonites sericea (Sowerby) Hall	(c)
7	Rhynchotrema capax (Con.) Hall and Clarke	(r)
8	Trinucleus concentricus Eaton	(aa)
9	Asaphus platycephalus Stokes	(a)
10	Calymmene callicephala Green	(r)
11	Stictopora elegantula Hall?	(r)
12	Crinoid segments	(r)

Similar layers are exposed at several points along the fault scarp toward Hoffman ferry but in general no accurate section can be measured on account of the derangement of the rocks produced by the fault which will now be described.

Hoffman ferry fault. By referring to the accompanying geologic map it will be seen that the group of limestones on which the city of Amsterdam is placed is abruptly sheared off along a line running nearly straight from the western central part of Charlton township to a point about one mile southwest of Pattersonville. From these points the line curves westward in its southern extension and is lost in the western declivity of Princetown hill. Northward it gives off several branch faults and has been traced by the early geologists of the New York survery and more recently by Mr Darton and Prof. Prosser to the Archaean mass northwest of Saratoga. The most interesting part however both from the standpoint of geology and of topography is at the deep glen north of Hoffman ferry, known as Wolf's hollow, where there is an escarpment on the western side of the glen forming a mural cliff of over 100 feet in places almost perpendicular. The glen has been cut presumably by the creek which may now be seen as a diminutive stream flowing by the roadside through the glen, where the soft shales of the Utica(?) and Hudson river formations lie inclined at a high angle against the hard resisting wall of Calciferous sandrock. One may see therefore on the one hand a wall of massive calcareous

sandstone rising in beetling cliffs, or more or less hidden by its own talus from which spring forest trees and a remarkable variety of ferns, and on the other hand a slope composed of black friable shales, with an occasional seam of smooth jointed sandstone, inclined at a sharp angle away from the precipitous cliff across the way. Lying almost perpendicularly against the foot of the limestone cliff are layers of very black, slaty shale undoubtedly belonging to the Utica though the shales seen in the slope across the highway are from the presence of layers of sandstone and their general lithologic characters, Hudson river. If the approximate base of the Hudson river is near the foot of the escarpment then taking the thickness of the Utica stage as 1200 feet there is a displacement here of over 1300 feet.

Northward from the "hollow" the escarpment becomes less pronounced though quite distinct for some miles farther. To the north the Trenton has been eroded from the Calciferous and the country to the east of the fault line is flatter so that there is not the decided contrast of formations. One may however see at various points the shales of the Utica or Hudson in fairly close connection with the massive sandstone of the Calciferous. A case of this sort occurs at a point 4.2 miles north of the Mohawk river. South of the river the line is nowhere as distinct as on the north side. It is however to be determined within a fair approximation as will be seen in another part of the present paper. The course of the Sandseakill may be in part determined by the presence of the fault, a supposition which is at least suggested by the topography of the locality.

East of the Sandseakill rises the high hill back of Rotterdam Junction. This hill is a conspicuous object to one looking at the sunset from the campus of Union college, its summit rising more than 1000 feet above the Mohawk at its foot. Just east of this hill flows the Plotterkill, a stream heading near Mariaville and reaching the Mohawk through a deep glen a mile and a half east of Rotterdam Junction. A short distance west of the mouth of the Plotterkill is the mouth of a small creek which flows down the northeastern slope of Waterstreet hill.[1] The shales and sandstones of the Hudson river stage are exposed in this creek for several

[1]On the U. S. geological survey's Amsterdam topographic sheet a triangulation bench mark is indicated on the northwestern brow of the hill at an altitude of 1279 feet A. T. and denominated Waterstreet.

hundred feet up the steep hillside. The lowest exposure is just beneath the arch of the West Shore railroad bridge where crumbling shale is exposed in the creek bed. Beginning at this point a section was measured by means of tape and Locke level.

21 **Rotterdam section**

I^1 Near the railroad arch in the bottom of the creek 8 feet of very thin, fragile, dark grayish to bluish black, argillaceous shales with occasional very thin sandy layers, one near the middle of the stratum being about 1 inch thick.	8′=	8′
I^2 Heavy, compact sandstone of grayish to greenish blue color, weathering gray to brown.	10′=	18′
I^3 Mainly grayish, friable shales with thin layers of sandstone.	12′=	30′
I^4 Heavy sandstone with intercalated shale.	6′=	36′
I^5 Dark crumbling shale.	8′=	44′
I^6 Shale with mainly thin, but some heavy layers of sandstone.	37′=	81′
I^7 Heavy stratum of sandstone.	4′=	85′
I^8 Shales with some thin layers of sandstone.	15′=	100′
I^9 Thick to thin and broken layers of sandstone.	10′=	110′
I^{10} Fine shale.	5′=	115′
I^{11} Thin broken sandstone with crumbling shale.	45′=	160′
I^{12} Shale.	5′=	165′
I^{13} Thin sandstone and shale. Base of high waterfall.	5′=	170′
I^{14} Thin friable blackish shale by excavation of which from beneath the sandstone above, the fall has been formed.	12′=	182′
I^{15} Two layers of massive sandstone over which the water falls.	8′=	190′
I^{16} Thin sandstone layers.	2′=	192′
I^{17} Clear dark shale.	4′=	196′
I^{18} Apparently heavy bedded sandstone weathering to thin often lenticular divisions.	25′=	221′
I^{19} Shales and thin sandstones.	10′=	231′
I^{20} Medium thick layers of sandstone with massive 2 foot layer at base and some thin beds of shale, and shaly partings.	39′=	270′

I[21] Mostly covered. Highly inclined layers of sandstone exposed in the creek banks 120 feet above no. 20. 120′= 390′

I[22] Covered to top of hill but with an occasional exposure of sandstone. 680 feet by barometer. 680′=1070′

In this section the shales are in general disposed in very thin irregular laminae so that they weather quickly to small angular sharp edged fragments. The joint structure of both sandstone and shale is well shown in almost every part of the section and specially at no. 20 where there is a vertical wall of 39 feet of sandstones and about 10 feet of shale. At the base of the section the dip is about 78 feet a mile to the south, but a little farther up stream it is reversed and a short distance farther up is again reversed and from thence is in general southerly and quite pronounced. It will be seen that the shale predominates in the lower half of the 270 feet of continuous exposures and sandstone in the upper half. In the first 160 feet there are 85 feet of shale and 75 feet of sandstones while in the remainder of the 270 feet there are 31 feet of shale and 79 feet of sandstone so that the total 116 feet of shale and 154 feet of sandstone shows that on the whole the sandstone predominates. Furthermore the higher in the section the more arenaceous are the shales themselves. The base of this section is probably not far above the top of the Utica stage. For less than two miles east of this locality about 200 feet of shales, graptolitic in the lower part, are exposed in a ravine a short distance west of the new Schenectady waterworks, which shales are probably the same passage bed noticed in the Minaville section (q. v.) The section also indicates that at least 1160 feet (from the elevations of the topographic sheet) of the Hudson river stage are present at this locality.

Descending the west side of Waterstreet hill into the valley of the Sandseakill, thin bedded sandstones with scarcely any shale are passed over till the bed of the creek is reached at the point where the road running on the eastern and northern slopes of Princetown hill crosses the creek. Here occurs an outcrop of blackish graptolitic shales, again closely resembling the passage bed of the Minaville section, and dipping strongly down stream and westerly. This exposure extends down the Sandseakill for a short distance when the creek bed becomes filled with debris largely

of glacial origin. In its lower course the creek flows between high banks of boulder clay.

The above section shows conclusively that the Hudson river terrane has its base below the present level of the Trenton formation which outcrops a short distance to the west. There is certainly a displacement in the strata at this point represented by the thickness of the Utica stage and probably in addition by a portion of the lower part of the Hudson river stage. The writer is also of the opinion that the graptolitic shales exposed on the Sandseakill are very near to if not coincident with this fault line. For the layers of this exposure are not only disturbed as indicated by the reversal of the dip, but they are apparently 300 feet lower than corresponding layers in the less disturbed strata west of this locality. Furthermore they are almost immediately succeeded by thin sandstones belonging to the upper or middle Hudson river stage, exposed in the northern slope of Princetown hill.

A short distance west of the Sandseakill one half mile southwest of Pattersonville the Trenton limestones outcrop and are extensively quarried.[1] A section was measured at this locality beginning with the Calciferous in the bottom of the canal at the long cut on the West Shore railroad west of Pattersonville station.

2B **Pattersonville section**

B[1] At the level of the bottom of the canal, compact, thick bedded layers of steel-gray, arenaceous limestone, weathering yellowish and containing abundance of flint. 30 feet in canal cut and 18 feet in railroad cut. Dip at western end of railroad cut 4° N, 55° W and at eastern end 4° in the opposite direction. Calciferous.	48′	48′

[1]In Smock's report these quarries are described as follows: "There are two quarries in the town of Rotterdam, Schenectady co. near Pattersonville station which are worked at intervals. They are opened in limestone on the hill 200 feet above the Mohawk river and half a mile south of Pattersonville station (West Shore railroad) and the Erie canal. That of James Walker was opened a few years ago when the New York, West Shore and Buffalo railroad was built. The face has a south 55° east course and a length of 150 yards, and has been worked back 75 feet from north to south. . . .The beds which are quarried range from 4 to 18 inches in thickness and the total thickness of the quarry beds is from 10 to 15 feet. At the west end there are two beds each 2 feet thick, of gray, semi-crystalline limestone. The dip is to the south-southeast at a small angle. . . Mrs Moore's quarry adjoins that of Walker's on the east, and with it makes really one continuous opening. . . It is 10 to 15 feet deep. The dip is 3° south-southeast. . . Here also the top strata are thin and the thick beds are at the bottom. . .Both these quarries are in the Trenton limestone."—*N. Y. state museum nat. hist. bul.* 3, Mar. 1888, p. 105, 106

B[2] Thick massive limestone fucoidal specially at the lower part. Fucoidal member of Calciferous. 135′= 183′

B[3] Just north of the Walker quarry in a small quarry at the head of a run south of an old lime-kiln, one foot of bluish drab, fine grained, compact limestone which weathers ash-gray. The outlines of several obscure fossils are visible on the upper surface of the layer, which rests on Calciferous sandrock. Birdseye. 1′= 184′

B[4] Above no. 3 are about 5 feet of thin, blue-black, fine grained, irregular, lumpy layers weathering light ash-gray, and fossiliferous specially abounding in Columnaria alveolata Goldfuss. In eastern side of quarry the rock is in thicker layers, the lower containing Columnaria. In the larger opening to the east the Columnaria bearing layers are capped by gray crystalline rock. Black river. 6′= 190′

B[5] In the Walker and Moore quarries the lowest rock exposed is dark bluish to grayish, crystalline, massive and weathers bluish gray. It is very fossiliferous. Trenton. 8′= 198′

B[6] Thin, irregular, dark blue, fine grained limestone layers with much intercalated black shale. Highly fossiliferous. Trenton. 14′= 212′

B[7] The nearest exposure of shales occurs about 50 feet above no. 6 in an open ditch on the northern slope of the hill. The sandstones of the Hudson river stage are exposed at an altitude of approximately 1200 feet A. T. The lower limit of the Hudson river at this point is probably nearly 1100 feet A. T. From highest exposure of Trenton to probable base of Hudson river, 888 feet. Utica. 888′=1100′

The fauna of the Black river, no. 4, is as follows:

1 Stromatocerium rugosum Hall (r)
2 Stictopora ramosa Hall (c)
3 Stictopora labyrinthica Hall? (r)
4 Monticulipora (Prasopora) lycoperdon Say (c)

5	Streptelasma profundum Hall	(c)
6	Streptelasma corniculum Hall?	(r)
7	Columnaria alveolata Goldfuss	(aa)
8	Zygospira recurvirostra Hall	(c)
9	Rafinesquina alternata (Con.) Hall and Clarke	(r)
10	Asaphus platycephalus Stokes	(r)
11	Leperditia fabulites Conrad	(a)
12	Orthoceras, sp.	(r)
13	Crinoid segments	(a)

The fauna of the Trenton, nos. 5 and 6, is as follows:

1	Monticulipora (Prasopora) lycoperdon Say	(a)
2	Streptelasma, sp.	(r)
3	Stictopora elegantula Hall	(c)
4	Stictopora ramosa Hall?	(r)
5	Subretepora reticulata Hall	(rr)
6	Tetradium columnare Hall	(rr)
7	Schizocrinus nodosus Hall	(aa)
8	Rafinesquina alternata (Con.) Hall and Clarke	(aa)
9	Plectambonites sericea (Sowerby) Hall	(c)
10	Orthis (Dalmanella) testudinaria Dalm	(c)
11	Orthis (Dinorthis) pectinella (Emm.) Hall	(r)
12	Rhynchotrema capax (Con.) Hall and Clarke	(r)
13	Cyclospira bisulcata (Emm.) Hall and Clarke	(rr)
14	Raphistoma lenticulare Emmons?	(r)
15	Murchisonia bellicincta Hall	(r)
16	Murchisonia gracilis Hall	(r)
17	Murchisonia, sp.	(r)
18	Asaphus platycephalus Stokes	(c)
19	Trinucleus concentricus Eaton	(r)
20	Dalmanites callicephalus Hall	(r)
21	Leperditia fabulites Conrad	(c)

The above section is of interest from the fine exposure of the Trenton limestones excellently adapted to the collection of fossils, and from the fact that it affords an excellent opportunity for determining the south dip of the strata by comparison with the exposure of Van Epp's hill exactly one mile to the north. The base of the Trenton on Van Epp's hill is approximately 590

feet A. T. while in the present section it is 450 feet A. T. which gives a dip of 140 feet a mile to the south.

The thin bedded appearance of the Black river limestone (no. 4) is apparently due to weathering. Almost uniformly the Black river in this region appears massive in fresh exposures, but after long exposure it exhibits an extremely irregular, lumpy structure, giving the general impression of irregularly thin bedded layers. The same is true of this limestone at Newport south of Trenton Falls and seems to be a very constant character.

Westward from this point the Calciferous is exposed in ledges above the West Shore railroad and the Trenton is exposed at intervals at an elevation of between 200 and 300 feet above the river. Along the highway passing through the small hamlet of Scotch Church are a number of exposures of the Utica shale, the highest being at an altitude of 1040 feet A. T. at a point .8 of a mile northeast of Scotch Church. The shale at this point is strongly calcareous, dull black with an olive tint, brown streak and weathers greenish brown. It is disposed in thin even laminae with smooth surfaces. Graptolites occur in moderate abundance but no other fossil was found. Similar shale is exposed at a point one quarter of a mile north of Scotch Church at an altitude of 1000 feet A. T. Slabby calcareous layers of several inches in thickness occur in the latter exposure. About one mile south by southwest of Scotch Church the fragile shales and brown-weathering sandstones of the Hudson river stage are exposed in the deep glen just west of the highway between Scotch Church and Mariaville. This exposure is at an altitude of about 1100 feet A. T. or 860 feet above the level of the Mohawk at Pattersonville. If the dip is 140 feet a mile this would indicate a thickness of 950 feet of Utica shales.

The Trenton is traced by its frequent outcrops in a narrow belt nearly parallel to the Mohawk but gradually approaching it to the westward. In both branches of the creek which empties into the Mohawk two and one half miles west of Pattersonville are fine sections from the Calciferous to the Utica, and west of this creek a series of quarries have been opened in the Trenton limestones and afford an excellent opportunity for any study of these rocks. A section was measured beginning at the level of the canal at the cut on the West Shore railroad nearly opposite Crane's village.

Plate 2

VAN EPPS HILL FROM QUARRIES AT PATTERSONVILLE

46C **Section opposite Crane's village on the south side of the Mohawk river**

C^1 Medium to thin bedded, irregular layers of calcareous sandrock, to canal level. In cut and creek east of cut. 52′= 52′

C^2 Heavy bedded massive sandstone exposed in cut and bed of creek just east of cut. 23′= 75′

C^3 Mostly covered. Steel gray arenaceous limestone containing flint. 80′=155′

C^4 Dove colored, very compact, even bedded, fine grained limestone with conchoidal fracture and weathering ash-white. Contains abundant examples of Phytopsis tubulosa Hall. Seen in lower quarry east of creek. Birdseye limestone. 2′-4′=159′

C^5 Dark bluish-black, massive, compact light-weathering limestone, containing Black river corals. Black river. Large quarry just east of creek. 6′=165′

C^6 Very compact dark blue limestone weathering light bluish gray. Thick bedded, even and of good quality for construction stone. Contains Rafinesquina alternata (Con.) Hall and Clarke, and other Trenton fossils. Large quarry east of no. 5. Trenton. 9′=174′

C^7 Irregularly bedded thin layers, highly fossiliferous, resting upon those of no. 6. Trenton. 12′=186′

C^8 Black smooth shale resting on the Trenton in the bed of the creek, and as fragments occurring in the soil of the hills to the south. Utica.

At the railroad cut where no. 1 and 2 are exposed the layers of no. 1 exhibit a rather abrupt bending amounting almost to a slight fault. Near the eastern part of the cut the dip is about 10° E and in the western part the dip is about 1° to the west. This section furnishes the best outcrop of the Birdseye limestone to be found in any part of this region. At this place the Birdseye presents its most typical characters. It is dove colored, impalpably fine grained, with flat conchoidal fracture, smooth joint faces, and

weathers ash-white with a delicate bluish tint. The peculiar plant-like reticulation of Phytopsis tubulosa Hall is very conspicuous in the rock at this locality since the former weathers buff whereas the matrix weathers nearly white. The vertical columns are larger than in the rock of this horizon near Newport and Littlefalls where they are quite small and composed of calcite, while in the Birdseye of the lower Mohawk they are composed of argillaceous or pyritiferous material. Within the limits of the exposure, a small quarry, the limestone varies from 2 to 4 feet in thickness, both delimiting terranes being in place. The upper surface of the subjacent Calciferous is uneven and hence the line between it and the overlying Birdseye is very sharply drawn. Above, the Birdseye seems to pass into the superjacent Black river without any sharp line of demarcation.

The following species were obtained from the Black river limestone, C^5:

1	Monticulipora (Prasopora) lycoperdon Say Branched form	(aa)
2	Streptelasma corniculum Hall	(c)
3	Streptelasma profundum Hall?	(r)
4	Stictopora elegantula Hall	(r)
5	Stictopora cf. ramosa Hall	(r)
6	Phytopsis tubulosum Hall?	(r)
7	Columnaria alveolata Goldfuss	(c)
8	Zygospira recurvirostra Hall	(c)
9	Plectambonites sericea (Sowerby) Hall and Clarke	(r)
10	Rafinesquina alternata (Con.) Hall and Clarke	(c)
11	Asaphus platycephalus Stokes	(r)
12	Hormoceras tenuifilum Hall	(r)
13	Crinoid segments	

The base of the Trenton stage in this section is 380 feet A. T. and in the Quarry hill one and one half miles to the north the base of the Trenton stage is 600 feet A. T. This gives a south dip of 1.47 feet a mile. By barometer the former point is 175 feet above the level of the Mohawk and the latter 400 feet, which gives the dip as 150 feet a mile to the south-southwest.

Along the creek which empties into the canal one and three-tenths miles due west of Crane's village station the following section was measured (46E):

E^5	Medium bedded in the lower layers, dark blue, fine grained limestone becoming thin bedded and shaly in the upper part. Contains large numbers of Trinucleus concentricus Eaton, and Monticulipora (Prasopora) lycoperdon Say.	18′=110′
E^4	Soil filled with boulders.	30′= 92′
E^3	Thin warped layers of arenaceous limestone weathering buff. Calciferous sandrock.	7′= 62′
E^2	Heavy, very compact layer of sandy limestone.	3′= 55′
E^1	Partly covered. Sandrock exposed in bed of creek near railroad.	52′= 52′

No. 3 of the above section is doubtless the thin bedded member often occurring at the summit of the Calciferous stage. Perhaps the 30 feet belong entirely to the Trenton stage. The thin layers of no. 5 are excellently adapted to collecting fossils and contain the two representative species of the upper Trenton of this region in abundance. A short time was spent in collecting at this point with the following result:

1	Monticulipora (Prasopora) lycoperdon Say	(c)
2	Stictopora acuta Hall?	(r)
3	Rafinesquina alternata (Con.) Hall and Clarke	(c)
4	Orthis (Dalmanella) testudinaria Dalm.	(c)
5	Rhynchotrema capax (Con.) Hall and Clarke?	(rr)
6	Modiolopsis cf. arguta Ulrich	(rr)
	See *Geol. surv. Minn.* v. 3, pt 2, pl. 36, fig. 6	
7	Asaphus platycephalus Stokes	(c)
8	Leperditia fabulites Conrad	(r)
9	Trinucleus concentricus Eaton	(a)
10	Raphistoma cf. lenticulare Emmons	(rr)
11	Crinoid segments	

Westward from this point the Calciferous is well exposed along the railroad, and an excellent section from the Calciferous to the Utica is afforded by the small creek half way between Crane's village and Port Jackson. The exposure of the Trenton in this sec-

tion is in a quarry in the bed of the creek on the estate of Benjamin Morphy. The section extends from the canal southward along a line passing near the next creek east of Morphy creek, at a point 1.3 miles south of the Morphy quarry, and thence through Adebahr hill.

46F **Section from Morphy's to the top of Adebahr hill**

F^1	Canal level. Thick bedded, steel gray arenaceous limestone with thinner mottled layers near the top which contain *Ophileta complanata* in abundance. Calciferous sandrock.	34′= 34′
F^2	Medium dark, dove colored, very compact fine grained limestone with conchoidal fracture and containing occasional examples of *Phytopsis tubulosa* Hall. Birdseye limestone.	4′= 38′
F^3	Dark blue, fine grained limestone, somewhat lumpy, weathering to an ash-gray. Contains corals. Base of Black river limestone.	5″
F^4	Dark blue fine grained limestone with occasional small crystals of calcite. Contains corals and *Rafinesquina alternata* (Con.) Hall and Clarke.	8″= 39′
F^5	Dark blue, fine grained, compact limestone with small sparkling crystals of calcite. Fossiliferous.	11″= 40′
F^6	2 feet covered, then 1 foot of dark blue fine grained limestone with sparkling crystals of calcite. Fossiliferous.	3′= 43′
F^7	Somewhat crystalline, blue fossiliferous layer. Base of Trenton substage.	3″
F^8	Compact, fine grained, bluish gray layer with glittering surface on fresh fracture. Fairly abundant Trenton fossils.	1′= 44′
F^9	Blue-black, fine grained massive limestone weathering bluish gray with yellowish fucoid-like markings on the vertical and horizontal faces. Well preserved specimens of *Rafinesquina alternata* are fairly abundant.	2′ 6″= 47′

Plate 3

Calciferous sandrock quarry in Morphy's creek; lower students at junction of Calciferous sandrock and Birdseye limestone

F10 Uneven, dark, compact, fossiliferous layer with crystalline lenticles, the fossils mostly in the lenticles. 1′= 48′

F11 Dark blue, fine grained layer with crystalline fossiliferous lenticles which by weathering darker and yellowish give a mottled appearance to the weathered surface. 1′ 2″= 49′

F12 Grayish blue, crystalline, fossiliferous layer. 4″

F13 Dark blue, fine grained with crystalline lenticles and weathering as in no. 11. Fossiliferous. 1′ 4″= 51′

F14 Medium light colored, weathering with yellowish streaks as in no. 11. Abounding in Trenton fossils. 2′= 53′

F15 Thin irregular, dark blue, fine grained layers with intercalated very black carbonaceous shale, contain great numbers of fossils specially Monticulipora (Prasopora) lycoperdon Say, and Trinucleus concentricus Eaton. 27′= 80′

F16 Utica shale exposed in creek bed, in contact with Trenton. Covered to first creek east of Morphy creek. 270′=350′

F17 Black strongly calcareous slaty shale containing veins filled with calcite and occasional compact fine grained layers with conchoidal fracture. 50′=400′

F18 Covered. 40′=440′

F19 Black, carbonaceous, calcareous shale with thicker compact layers in bed of creek and to first branch not far below the highway north of Adebahr hill. 60′=500′

F20 Fragments of shale in soil of hillside, becoming specially abundant in knoll on northeastern declivity. 180′=680′

F21 Top of Adebahr hill. Black crumbling, calcareous shale, with thicker compact layers, exposed in open pasture on southern brow of hill. 140′=820′

The bench mark on the southern crest of Adebahr hill is 1062 feet A. T. and the level of the Mohawk river at the base of the

section is 260 feet A. T. giving a difference of 800 feet which corresponds closely with the result obtained by the barometer. The members of the Calciferous and Trenton stages of this section were measured by Mr Darton with a somewhat different result from that obtained by the writer.[1] No. 2-15 of the present section were measured very carefully with a tape. In Darton's section the Birdseye is given as above the Black river. There does indeed seem to be a peculiar blending of the lithologic characters of the massive member of the Trenton and the Black river in no. 8 and 9, so that there is not a sharp line between the two substages. The Birdseye is well defined however in its proper stratigraphic position, being sharply separated from the subjacent Calciferous and less sharply but distinctly from the superjacent Black river. The upper, thin bedded member of the Trenton substages is well shown and seems to pass gradually into the Utica though the faunal line between the two is distinct enough. The Utica shale is exposed at intervals from Morphy's to the top of Adebahr hill, a vertical distance of 740 feet. The distance from Morphy's to the bench-mark on Adebahr hill is three miles, hence if the south dip is 140 feet a mile the Utica in this section has an actual thickness of 1160 feet.

The next exposure of Trenton west of Morphy's is at the Stanton[2] quarries a mile and a quarter east of Port Jackson. A section at this quarry is as follows (451):

I^4 Dark blue limestone of somewhat crystalline structure.	1′ 6″=19′
I^3 Darker blue limestone containing corals (Streptelasma), very massive and compact	3′ 6″=17′ 6″
I^2 Bluish drab, very compact, fine grained limestone. Lithologic characters substantially those of the Birdseye limestone.	2′=14′
I^1 Covered to level of West Shore railroad.	12′=12′

[1] 13th annual report N. Y. state geologist, p. 426, 427.

[2] Vanuxem mentions this quarry in several places in his report. His description of it is as follows: "The rock base of the Trenton at Stantons is a very solid mass with very few divisions or layers, of a light gray color and crystalline. Some of the layers or portions are over 6 feet thick. The lower layer is nearly 7 feet thick, the next 4, the upper about 2. The rock is of good quality with fewer knobs or accretions than in some other localities and with more of the Birdseye character than in the other quarries. The surface of the rock is water worn, being quite smooth in some places, and scratched, the direction of the scratches nearly east and west." (*Geology of New York*, pt 3, p. 44) and again "The upper mass of the Black river limestone, of which the Birdseye forms the lower part embraces the greater part of the gray limestones at . . . Stanton's quarry at the east end of Port Jackson". (p. 250)

TRENTON LIMESTONE IN MORPHY'S CREEK; STUDENT STANDING ON CONTACT OF BLACK RIVER AND TRENTON LIMESTONES

The lines of division between no. 2, 3 and 4 are very indistinct and indeed their respective layers seem almost to pass into each other. No doubt the opening of the quarry was deeper when Vanuxem saw it for it has not been worked for many years and the floor is entirely hidden by soil. The rock is too compact for the exhibition of its fossils. If the quarry is again opened, as it no doubt will be during the improvements in progress on the Erie canal, the collection of fossils will be less difficult.

The farthest west of any exposure of Trenton noticed on the south side of the Mohawk was in the small creek which empties into the canal about a mile east of Port Jackson at an altitude of 40 feet above the canal. This exposure consists of one thick layer of crystalline, fossiliferous Trenton limestone.

In the valley of the South Chuctanunda creek are numerous exposures of the Utica shale. It outcrops in a fine cliff about 60 feet above the canal. In the slope of the hill southwest of Minaville, at a point about 1.4 miles south by southwest of the center of the village, the Utica shale is exposed in several small glens. A section was measured here beginning at the level of the Chuctanunda and extending to the top of the hill.

45K **Minaville section**

K^4 Mostly covered. Thin sandstones and arenaceous shales with a massive 2 foot layer at the base in the head of a deep glen 120′=540′

K^3 Black shales becoming olive to blackish at the top. These shales show a transition from the black arenaceous shales of the Utica to the arenaceous, thin, crumbling shales of the Hudson river stage. 165′=420′

K^2 Top consisting of slaty layers containing graptolites in abundance. Black, even shale. 90′=255′

K^1 Mostly covered, but showing brown-weathering, slabby shale in the west bank of Chuctanunda creek, just above Minaville. 165′=165′

The above section is the only one seen in this region that shows the passage from the Utica to the Hudson river stage, and is of special interest on this account. Within the limits of a continuous exposure of 255 feet of shales there is exhibited a complete

transition from the typical lithologic characters of the Utica to those of the Hudson. The Utica at the lower part of this exposure is black with brownish streak and weathers brown to dark brown with a greenish tint. It is strongly calcareous and disposed in well-defined layers which usually split into laminae having smooth flat surfaces. These in turn crumble to square edged fragments. In some cases there are coherent layers of several inches in thickness, quite hard and breaking with conchoidal fracture. The shale in the upper part of this exposure is blackish to dark olive or grayish, very fragile and weathers dirt brown. It is not sufficiently calcareous to effervesce with cold acid, and is disposed in layers which break up into irregular laminae with uneven rounded surfaces which in turn weather to small, thin, sharp-edged, usually quadrilateral scales that readily pass into soil. No fossils were found in the shales above the graptolite bed though they probably contain some graptolites, and no fossils other than graptolites were found in the graptolite bed.

Conclusions

The writer has made no special study of the Calciferous stage. It is everywhere easily recognized. Its greatest thickness in this region is at Hoffman ferry (section 2A) where there are 350 feet without reaching the base of the stage. The two lamellibranchs from no. 45C[3] have not been identified and may prove to be new species.

The Birdseye is not difficult to recognize in this region. It is uniformly a compact, very fine grained, dove colored, dolomitic limestone. In most cases the fossil Phytopsis tubulosa Hall is rare, but in one or two places, as section 46C and the small quarry on the north side of the highway two miles north of Crane's village, this fossil fills the rock. If the lithologic characters of the Phytopsis tubulosa horizon in section 46C be carefully studied and the basal member of the Trenton stage in the other section be compared with it, there will be very little hesitancy in accepting the statement that the Birdseye limestone is present as a basal member throughout the region, but with variable thickness and apparent uncomformity with the Calciferous. Its thickness varies from less than a foot to 5 feet and is less in the eastern part of the region than in the western part.

With the Black river limestone the case is more difficult. In truth it is only under favorable circumstances that the Black river can be clearly distinguished from the overlying Trenton. In section 46A the Columnaria zone has a thickness of from 7 to 9 feet and is followed by a conspicuously darker-weathering, semi-crystalline limestone with an appreciable stratigraphic break. In section 2B the contrast between this zone and the basal member of the Trenton substage is even more marked, since in the latter section the Trenton is looser grained and weathers darker than in the western part of the region. In section 2D there is a decided contrast in color between the Columnaria zone and the subjacent Birdseye, but no stratigraphic break. The two appear to constitute one layer, a fact which is also very noticeable at Newport, N. Y. in the quarries about two miles north of the village. The thickness of the Black river in 2D is apparently only $3\frac{1}{2}$ feet, and it will be noticed that in this part of the region the massive member of the Trenton substage is unusually thick. The lumpy structure mentioned by the early New York geologists as a character of the Columnaria horizon at Watertown is its most constant lithologic character in the present region. The fauna of the Black river limestone is of interest. The three fossils Stromatocerium rugosum, Streptelasma profundum and Columnaria alveolata never pass above it. The brachiopoda so abundant in the immediately overlying Trenton are very poorly represented in the Black river. The most common brachiopod of the latter rock, Zygospira recurvirostra, is uncommon or lacking in the former. Rafinesquina alternata may usually be found in small numbers in any exposure of Black river well adapted to collection. The obscure bryozoa of the genus Stictopora are usually present. Monticulipora (Prasopora) lycoperdon occurs associated with the Columnaria but is invariably the branched form, while in the upper member of the Trenton substage where that fossil is so abundant it is the hemispheric form that is common. These faunal differences between the Trenton and Black river substages are constant throughout the region in spite of variations in lithologic characters. The affinities of the Black river limestone are however with the Trenton limestone and not with the Birdseye.

The Trenton substage is composed of two members, a lower, massive, crystalline and an upper, thin bedded, fine grained member. The lower member is usually about 8 feet in thickness and the upper probably not far from 30. In section 46F where the Utica is present the thickness of this upper member is 27 feet. Trinucleus concentricus and Monticulipora (Prasopora) lycoperdon are the characteristic fossils of this member and the former is scarcely found below it. It is interesting to note that at Trenton Falls and Rathbone brook these two fossils are found similarly associated in the lower layers of the Trenton. This would lead us to conclude that the massive member at the base of the Trenton in its eastern extension is related to the Black river limestone, and does not correspond to the massive member at Trenton Falls which occurs at the summit of the stage. The greatest thickness of the Trenton stage measured in this region is 46 feet, at Morphy's, 46F.

The accompanying chart illustrates the distribution of the species listed from the Calciferous and Trenton stages. In the vertical columns the relative abundance of the species for any locality, as indicated at the heads of the columns, is given by a letter opposite the name of the species. The meaning of the letters is the same as explained in another place. The starred localities are those from which no extensive collection was made.

The lithologic characters of the Utica and Hudson river shales were described in some detail in the discussion of the Minaville section, for the purpose of showing that in this region at least the two formations may be separated by a fairly definite line. The transition is not marked till within 165 feet of the Hudson sandstones and after the sandstones are reached they tend soon to predominate as seen in the Rotterdam section. The Utica stage has a thickness in this region of between 950 and 1260 feet composed entirely of black calcareous shales and thin layers of limestone. The hill back of Rotterdam, reaching an elevation of 1200 feet above the Mohawk, is entirely composed of argillaceous shale and sandstones without any appreciable amount of calcareous material.

A maximum section for this region is as follows:

6 Argillaceous crumbling shales and sandstones. Hudson river. 1200′=2802′

5 Black slaty calcareous shales and thin limestones. Utica. 1200′=1602′

DISTRIBUTION OF SPECIES	45				46												2										
	*A⁹	*A⁶	C³	G⁵	*A⁹	*A⁸	A⁷	C⁴	C⁵	*C⁶	E⁵	*F¹	*F²	*F⁴	*F⁹	*F¹⁵	*A³	*A⁴	*A⁵	B⁴	B⁵	B⁶	D²	D³	E²	E³	F
Plantae?																											
Phytopsis tubulosa Hall								aa	r				r														
Phytopsis cellulosa Hall							?		r																		
PROTOZOA?																											
Stromatocerium rugosum Hall																				r							
COELENTERATA																											
Streptelasma corniculum Hall	?								c											r	?						
Streptelasma profundum Hall	?						c		?r											c			? c				
Columnaria alveolata Goldfuss						r	a		c								r			aa			c				
Tetradium columnare Hall																					rr						
Monticulipora (Prasopora) lycoperdon Say				r			r				c					aa				c	a		r		aa		r
Protarea vetusta Hall																									r		
ECHINODERMATA																											
Schizocrinus nodosus Hall				a							?									?	aa						?
ARTHROPODA																											
Leperditia fabulites (Conrad)				r							r									a	c		c				
Trinucleus concentricus Eaton											a					aa			c		r						aa
Ceraurus pleurexanthemus Green																							rr				
Calymmene callicephala Green																											r
Dalmanites callicephalus																					r						
Asaphus platycephalus Stokes				r	c				r		c									r	c		r				a
MOLLUSCOIDEA																											
Bryozoa																											
Escharapora recta Hall																									r		r
Stictopora acuta Hall				r							r												r				
Stictopora elegantula Hall									r												c		r				r
Stictopora labyrinthica Hall																				r							
Stictopora ramosa Hall									r											c	r		c				
Subretepora reticulata Hall																					rr						
Brachiopoda																											
Lingula acuminata Conrad			r																								
Lingula quadrata Eichwald																											r
Orthis (Dinorthis) pectinella (Emm.) Hall				c																	r				c		
Orthis (Dalmanella) testudinaria Dalman				c							c										c						a
Rafinesquina alternata (Con) Hall and Clarke	a			a	a		r		c	a	c			c	c			a		r	aa			c	aa		c
Plectambonites sericea (Sowerby) Hall				c					r												c				c		c
Zygospira recurvirostra Hall				r					c											c			c				
Rhynchotrema capax (Con.) Hall and Clarke				r							r										r		r				r
Cyclospira bisulcata (Emm.) Hall and Clarke																					rr						
MOLLUSCA																											
Lamellibranchiata																											
Sp. indet			r																								
Sp. indet			rr																								
Modiolopsis cf. arguta Ulrich											rr																
Gastropoda																											
Murchisonia bellicincta Hall							r														r						
Murchisonia gracilis Hall																					r						
Murchisonia sp																					r						
Ophileta complanata Vanuxem			a									a															
Raphistoma lenticulare Emm											rr										r						
Cephalopoda																											
Orthoceras sp																				r							
Hormoceras tenuifilum Hall									r																		

4 Thin to thick bedded limestone, characterized by abundant individuals of Rafinesquina alternata. Trenton. 38′= 402′

3 Dark colored lumpy limestone, characterized by Columnaria alveolata. Black river. 9′= 364′

2 Dove colored very fine grained limestone, characterized by Phytopsis tubulosa. Birdseye. 5′= 355′

1 Thick to thin bedded, flinty, arenaceous limestone. Calciferous. 350′= 350′

Discussion of maps and sections

On the geologic map of the state of New York published in 1844[1] the Califerous is shown as extending northeasterly from Rotterdam and westerly along the Mohawk on the south side of the river, extending a mile or more to the south. On the map which accompanied the New York mineral exhibit at the Columbian exposition,[2] the Calciferous and Trenton stages are not separately mapped. The eastern and southern boundary of the lower Ordovician is indicated as extending from Hoffmans to West Charlton and northward, and on the south side of the Mohawk for two miles south of Pattersonville and thence westerly along the Mohawk joining that at Tribeshill. The Utica-Hudson river terrane adjoins the Calciferous-Trenton along this boundary line and also covers the region west of Amsterdam and north of Aiken, between Amsterdam and Tribeshill. On the large map recently published[3] the Calciferous and Trenton stages are separately mapped. The Calciferous extends from Hoffmans (not from Hoffmans as located on the above map for it is there wrongly located, being too far east) north to Galway and northward, and westerly in a narrow belt along the south side of the Mohawk to opposite Aiken (three miles west of Amsterdam). The Trenton forms a small patch north of Hoffmans and extends along the southern

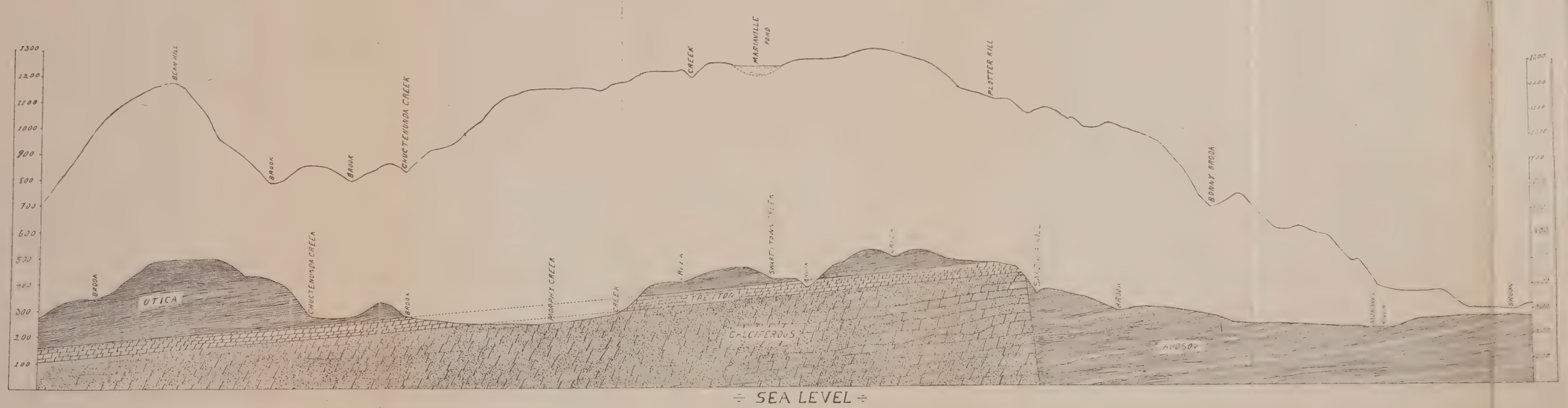
[1]The full title of this map is, "Agricultural and geological map of the state of New York by legislative authority 1844."

[2]Economic and geologic map of the state of New York showing the location of its mineral deposits, by Frederick J. H. Merrill, director New York state museum, 1894.

[3]Geological survey of the state of New York. Preliminary geological map of New York exhibiting the structure of the state so far as known, prepared under the direction of James Hall by W. J. McGee. Published by authority of the legislature of the state of New York. Printed by the U. S. geological survey. J. W. Powell, director, 1894.

boundary of the Calciferous in a very narrow belt crossing the river at about Aiken and extending thence eastward in a broad belt to north of Crane's village, with an outlier about two miles north of the latter place. The lower part of Amsterdam is colored as Calciferous. The belt of Trenton on which Rockton is situated is represented as skirting the western bank of the Chuctanunda passing near Hagaman, and to the west passing under the area of Utica to the west of Amsterdam and north of Aiken. A small patch of Utica is mapped north of Hoffmans.

Accompanying the present paper is a map based on the Amsterdam sheet of the U. S. geological survey, and several profile sections. One is a section along a direct line passing through the summit of Van Epp's hill, Quarry hill, the Donlon quarry and a point just south of the Amsterdam secondary reservoir (Hoffmans). The nature of the Hoffmans ferry fault is well shown and a slight syncline in which the Chuctanunda creek flows. This syncline is probably the cause of the peculiar distribution of the Trenton rocks in the city of Amsterdam. Another is a section along a line through the Moore-Walker quarries, reaching the Mohawk at a point one half mile west of Aiken. Some of the sections described are illustrated by the sketched position along this profile. This also shows the relations of the Utica and Hudson river terranes to the lower Silurian, specially the south dip of the strata and its effect upon estimates of thickness.



÷ SEA LEVEL ÷

A SECTION ACROSS THE AMSTERDAM SHEET JUST SOUTH OF THE MOHAWK RIVER AND A PARALLEL SECTION FIVE AND ONE HALF MILES TO THE SOUTH.

BY WILLIAM L. FISHER.

SCALE

VERTICAL 1 IN. = 200 FT.

HORIZONTAL 2 IN. = 1 MILE.

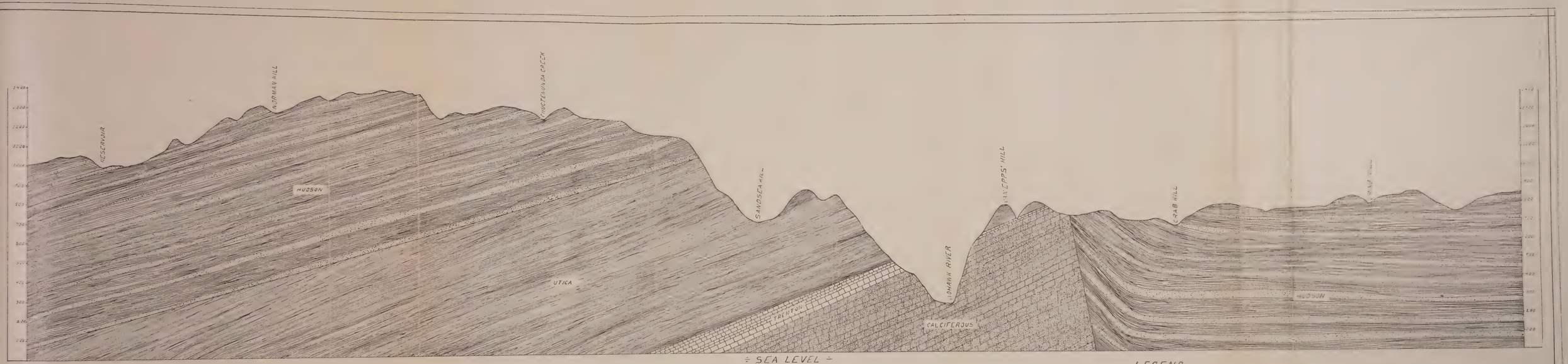
LEGEND

UTICA

TRENTON

CALCIFEROUS

HUDSON



A SECTION ACROSS THE AMSTERDAM SHEET FROM THE NORTHEAST CORNER TO DELANSON

BY WILLIAM L. FISHER.

SCALE

VERTICAL 1 IN = 200 FT

HORIZONTAL 2 IN = 1 MI.

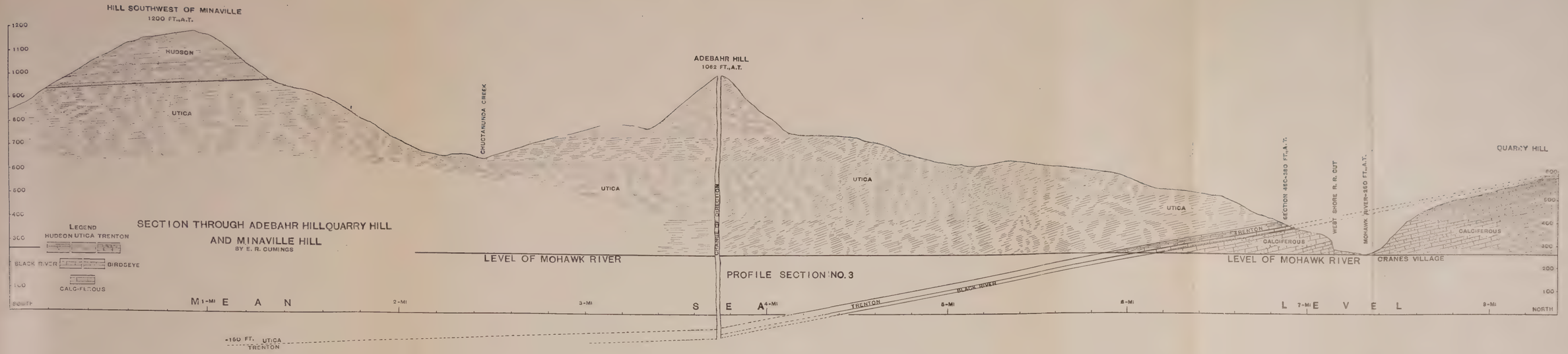
LEGEND

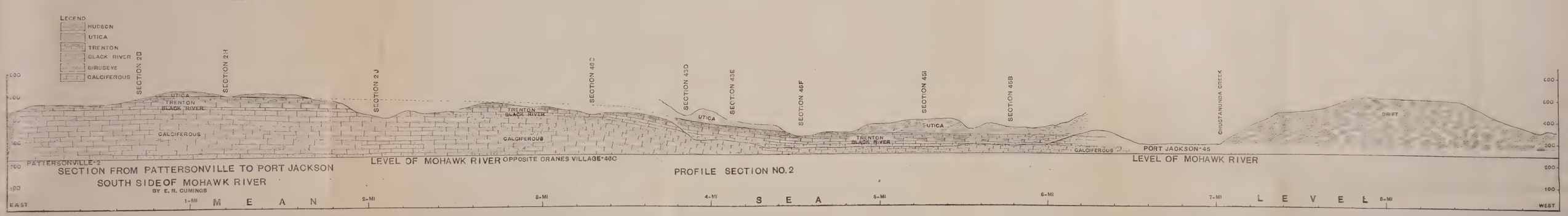
HUDSON

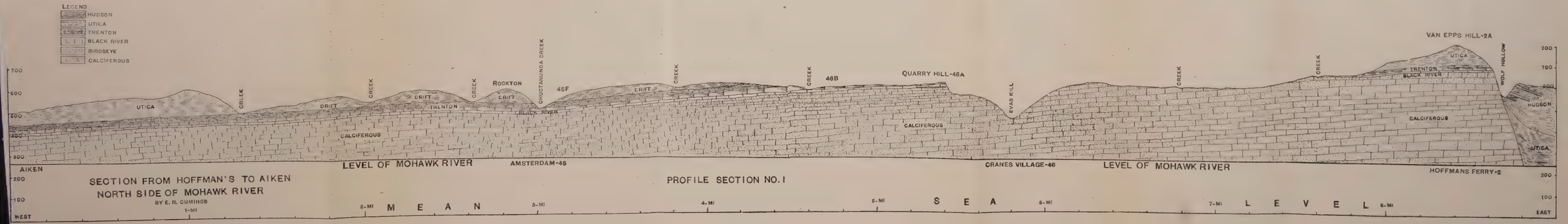
UTICA

TRENTON

CALCIFEROUS


HILL SOUTHWEST OF MINAVILLE
1200 FT.,A.T.
HUDSON
UTICA
ADEBAHR HILL
1062 FT.,A.T.
CHUCTANUNDA CREEK
UTICA
UTICA
UTICA
CRANE OF DIRECTION
SECTION 46C-380 FT.,A.T.
WEST SHORE R. R. CUT
MOHAWK RIVER-260 FT.,A.T.
QUARRY HILL
TRENTON
CALCIFEROUS
CALCIFEROUS
LEGEND
HUDSON UTICA TRENTON
BLACK RIVER
BIRDSEYE
CALCIFEROUS
SECTION THROUGH ADEBAHR HILLQUARRY HILL
AND MINAVILLE HILL
BY E. R. CUMINGS
LEVEL OF MOHAWK RIVER
LEVEL OF MOHAWK RIVER
CRANES VILLAGE
PROFILE SECTION NO. 3
TRENTON
BLACK RIVER
-160 FT. UTICA
TRENTON
SOUTH
M 1-MI E A N 2-MI 3-MI S E A 4-MI 5-MI 6-MI 7-MI L E V E L 8-MI
NORTH


LEGEND
HUDSON
UTICA
TRENTON
BLACK RIVER
BIRDSEYE
CALCIFEROUS
SECTION 2 J
SECTION 46
SECTION 43D
SECTION 43E
SECTION 46F
SECTION 45I
SECTION 45B
CHUCTANUNDA CREEK
UTICA
TRENTON
BLACK RIVER
CALCIFEROUS
UTICA
TRENTON
BLACK RIVER
CALCIFEROUS
UTICA
TRENTON
BLACK RIVER
CALCIFEROUS
DRIFT
PATTERSONVILLE-2
LEVEL OF MOHAWK RIVER
OPPOSITE CRANES VILLAGE-46C
CALCIFEROUS
PORT JACKSON-45
LEVEL OF MOHAWK RIVER
SECTION FROM PATTERSONVILLE TO PORT JACKSON
SOUTH SIDE OF MOHAWK RIVER
BY E. R. CUMINGS
PROFILE SECTION NO. 2
EAST
1-MI M E A N 2-MI 3-MI 4-MI S E A 5-MI 6-MI 7-MI L E V E L 8-MI
WEST


LEGEND
HUDSON
UTICA
TRENTON
BLACK RIVER
BIRDSEYE
CALCIFEROUS
UTICA
DRIFT
CREEK
DRIFT
CREEK
DRIFT
TRENTON
BLACK RIVER
CALCIFEROUS
CREEK
ROCKTON
DRIFT
CHUCTANUNDA CREEK
45F
DRIFT
CREEK
46B
QUARRY HILL-46A
EVAS KILL
CALCIFEROUS
CREEK
CREEK
VAN EPPS HILL-2A
UTICA
TRENTON
BLACK RIVER
WOLF HOLLOW
HUDSON
CALCIFEROUS
UTICA
AIKEN
LEVEL OF MOHAWK RIVER
AMSTERDAM-45
CRANES VILLAGE-46
LEVEL OF MOHAWK RIVER
HOFFMANS FERRY-2
SECTION FROM HOFFMAN'S TO AIKEN
NORTH SIDE OF MOHAWK RIVER
BY E. R. CUMINGS
PROFILE SECTION NO. 1
WEST
1-MI 2-MI M E A N 3-MI 4-MI 5-MI S E A 6-MI 7-MI L E V E L 8-MI
EAST

NOTES ON THE STRATIGRAPHY OF THE MOHAWK VALLEY AND SARATOGA COUNTY

BY

CHARLES S. PROSSER

MOHAWK VALLEY

Sections at Ingham Mills

Along the East Canada creek at Ingham Mills are interesting exposures of the lower Trenton formation which show a recurrence of the lithologic characters of the Birdseye limestone above the Black river limestone. The following section is shown on the bank of the creek and in the quarry just above the highway bridge at the mills:

	Feet
77B[1] Somewhat arenaceous limestone which extends to the creek level. In some of the layers are markings like great fucoidal stems. The rock is like impure Birdseye limestone.	$5\frac{4}{12}=5\frac{4}{12}$
B[2] Drab colored typical Birdseye limestone.	$10\frac{8}{12}=16$
B[3] Black lumpy limestone having the lithologic appearance of the Black river limestone.	$5\frac{4}{12}=21\frac{4}{12}$
B[4] Light gray to drab layer having the lithologic appearance of the Birdseye limestone.	$1\frac{5}{12}=22\frac{3}{4}$

On the highway above the mill this stratum is 2 feet, 5 inches in thickness with vertical markings like Phytopsis. Mr Darton has described a section at this place[1] but I was unable to locate it or its divisions precisely.

By the highway above the mill another section was measured which gives higher rocks than the one just described:

	Feet
77C[1] Massive limestone layers which are quarried and at the same horizon apparently as the quarry at the mill.	$6\frac{10}{12}=6\frac{10}{12}$
C[2] Birdseye-like stratum	$2\frac{5}{12}=9\frac{3}{12}$
C[3] Non-Birdseye-like stratum	$2\frac{3}{12}=11\frac{1}{2}$

[1] 13th annual report N. Y. state geologist, p. 422, 423.

	Feet
C^4 Birdseye-like stratum	$1\frac{1}{6}=12\frac{2}{3}$
C^5 Thin bedded Trenton limestone containing Trenton fossils, with some shaly layers.	$12\frac{1}{2}=25\frac{1}{6}$

The interesting thing in this cliff is the occurrence of the two strata, C^2 and C^4, with the lithologic characters of the Birdseye limestone above the massive limestone of C^1 which is apparently the Black river limestone.

Schoharie creek section

In a recent paper the writer and Mr Cumings described a section on Bean hill southwest of Minaville where the transition from the Utica slate to the Hudson river formation is clearly shown.[1] Since then the writer has discovered a cliff on the Schoharie creek where the transition is beautifully shown and is almost as marked as that between any other two formations in eastern New York. This cliff is on the western side of the creek opposite the house of William Bega, three miles south of Mill Point, about seven and one half miles southwest of Amsterdam and seven and one fourth miles south of Tribeshill station. The section beginning at the level of Schoharie creek near the northern end of the cliff and extending nearly to the top of the hill is as follows:

	Feet
$45X^1$ Clear black shale from the water to the base of the lowest sandstone stratum in the cliff, 114′ by level and 105′ by barometer. At the sandstone stratum there is a decided lithologic break from the black argillaceous shales below. Utica slate.	$114=114$
X^2 Grayish sandstones alternating with bluish argillaceous shales to the top of the cliff. Hudson river formation.	$195=309$
X^3 Mostly covered from the top of the cliff to the highway.	$15=324$
X^4 Occasional ledges of sandstone show on the side of the hill from the highway nearly to its top. Hudson river formation.	$120=444$

In this cliff the Utica shale is all black and highly argillaceous up to the base of the Hudson river sandstones. The lowest sandstones are thin bedded with some blue shales; but a little higher are thick,

[1] 15th annual report N. Y. state geologist, 1898, p. 650.

BEGA'S CLIFF ON SCHOHARIE CREEK; UTICA SHALE AT BASE, HUDSON RIVER ABOVE

massive sandstones and still higher are thinner sandstones alternating with bluish shales. The line of division between the Utica and Hudson river is clear and sharp and there is no question in reference to the separation of these two formations as seen in this cliff. A fairly good idea of its geological appearance may be gained from the accompanying picture taken from the eastern bank of the creek. The Utica shale shows near the southern end of the cliff, a little farther south than the Bega house, while the Hudson river in the bank above is mostly covered.

About a mile and a quarter down the creek from the Bega cliff is another conspicuous one on the western bank, opposite the Overbaugh farm and a short distance below the ford. This cliff is composed of the Utica slate which is finely exposed for at least 160 feet. The dip is about $3\frac{1}{2}°$ S, 20° E.

On the eastern bank of the creek just north of Mill Point there is a splendid exposure of till or boulder clay. The lower part of the bank is composed of blue clay containing numerous boulders, some of them of large size, while the upper part is somewhat yellowish in color. The barometer gave a thickness of 130 feet for this deposit. Along the middle course of many of the streams entering the Mohawk river from the south is a deposit of boulder clay but in no other locality has such a thick and fine exposure been found.

Bean hill section

Near the northern end of Bean hill several fair exposures near the contact of the Utica slate and Hudson river formation have been noted. In the upper part of the small creek on the eastern side of the hill and near the highway crossing its northern end are good outcrops of the Utica slate in the glen above the Bussing farmhouse. The section from the level of South Chuctanunda creek at the highway bridge to the sandstones near the summit of the highway is as follows:

	Feet
45 Y^1 Covered from creek level to shale in creek above Bussing's house.	90= 90
Y^2 Black argillaceous Utica shale to fork of creek.	70=160
Y^3 Similar black shale along eastern fork of creek for 167 feet when a slightly arenaceous stratum occurs.	167=327

Feet

Y4 Black argillaceous shales nearly to the head of the creek. 56=383

Y5 Partly covered, but in the upper part at the head of the glen are iron-stained shales which weather yellowish and are somewhat transitional from the Utica to the Hudson river. 19=402

Y6 Mostly covered in the field southeast of glen; sandstone in terrace at top which is perhaps not in place. 19=421

Y7 Covered, but at top conspicuous ledge of Hudson river sandstone. 24=445

On the western side of Bean hill the contact of the Utica slate and Hudson river formation is shown on the Charles Overbaugh farm in a gully on the northwestern side of the highway a short distance south of the house. There is a pominent sandstone stratum just below the road below which are black argillaceous and calcareous shales. Mr Fisher found this black shale for 50 feet below the sandstone some of the joints in which had been filled with calcite; but saw no indications of sandstones or arenaceous shales. Again in the gully by the house on the south side of the highway is another exposure of the contact of the black Utica shale and Hudson river sandstone. The black carbonaceous shale is shown in the run about opposite the house, and a little higher is a heavy sandstone stratum.

Swartstown creek section

An excellent section from the upper part of the Calciferous sandrock through the Trenton formation to the base of the Utica slate, is that along Swartstown creek on the south side of the Mohawk river about three fourths of a mile below Crane's village. This section is an interesting one to compare with the one already described opposite Crane's village.[1]

Feet

461[1] Covered from river level to the base of the first cascade in Swartstown creek. 72= 72

1[2] Arenaceous, light gray, massive limestone. On one of the layers, 6½ feet above the base of the lower part of the first cascade, are specimens of Ophileta complanata Van. The top of this

[1]13th annual report N. Y. state geologist, p. 654, 46C.

CALCIFEROUS SANDROCK IN SWARTSTOWN CREEK; STUDENTS INDICATING LAYER CONTAINING OPHILETA

	Feet
part of the cascade is formed by a massive layer 4 feet, 8 inches in thickness extending to the base of the upper part of the cascade. The rocks forming the upper and lower parts of this cascade have a thickness of 26½ feet. Calciferous formation.	92=164
I³ Drab colored limestone under highway bridge. Birdseye limestone. The base rests on top of the Calciferous impure limestone in the bed of the creek and the top is shown in the vertical ledge of rock under the bridge.	5½=169½
I⁴ Dark gray to blackish lumpy limestone about 7½ feet thick. Black river limestone.	7½=177
I⁵ Thin bedded, dark blue limestone extending above the house of Mr John Swarts. Part of the layers are very fossiliferous. Trenton limestone.	43=220
I⁶ Some 2 feet of black argillaceous shale in the creek just above the Swarts barn. Utica slate.	2=222

To the north of the creek on the Swarts farm is a small quarry in the Birdseye where 5½ feet of this limestone is shown capped by the Black river. Along this terrace for one mile from Swartstown creek to that opposite Crane's village there are quite frequent outcrops of the Birdseye and Black river limestones in which a number of quarries have been opened. The Birdseye limestone is shown in this ledge to better advantage than at any other locality in the lower Mohawk valley, specially in the woods about south of Crane's village near the old Phillips quarry. The limestone is light drab in color, very compact and fine grained and contains numerous and beautiful specimens of Phytopsis tubulosa Hall; in every respect this is typical Birdseye limestone. The southern wall of an old quarry in this terrace about south of Crane's village gives the following vertical section:

	Feet
46K¹ Lower part of quarry wall apparently resting on the Calciferous limestone. Birdseye.	7½= 7½
K² Very dark gray or blackish lumpy limestone. Black river.	7⅝=15⅛
K³ Very fossiliferous, thin bedded, blue limestone; 5 feet, 10 inches in the eastern and 8 feet, 10 inches in the western part of the quarry wall. Trenton limestone.	8⅝=24⅛

Amsterdam section

On the northern bank of the Mohawk, not far above the river bridge at Amsterdam the Birdseye and Black river subformations of the Trenton are shown.

	Feet
45 Z^1 Arenaceous limestone to the river level. Calciferous formation.	5=5
Z^2 Drab compact limestone of the Birdseye. Not typical in appearance.	8=13
Z^3 Very dark gray, somewhat lumpy limestone. Black river.	8=21
Z^4 At top of the ledge about 1 foot of lighter gray limestone containing Trenton fossils. Trenton limestone.	1=22

Pattersonville section

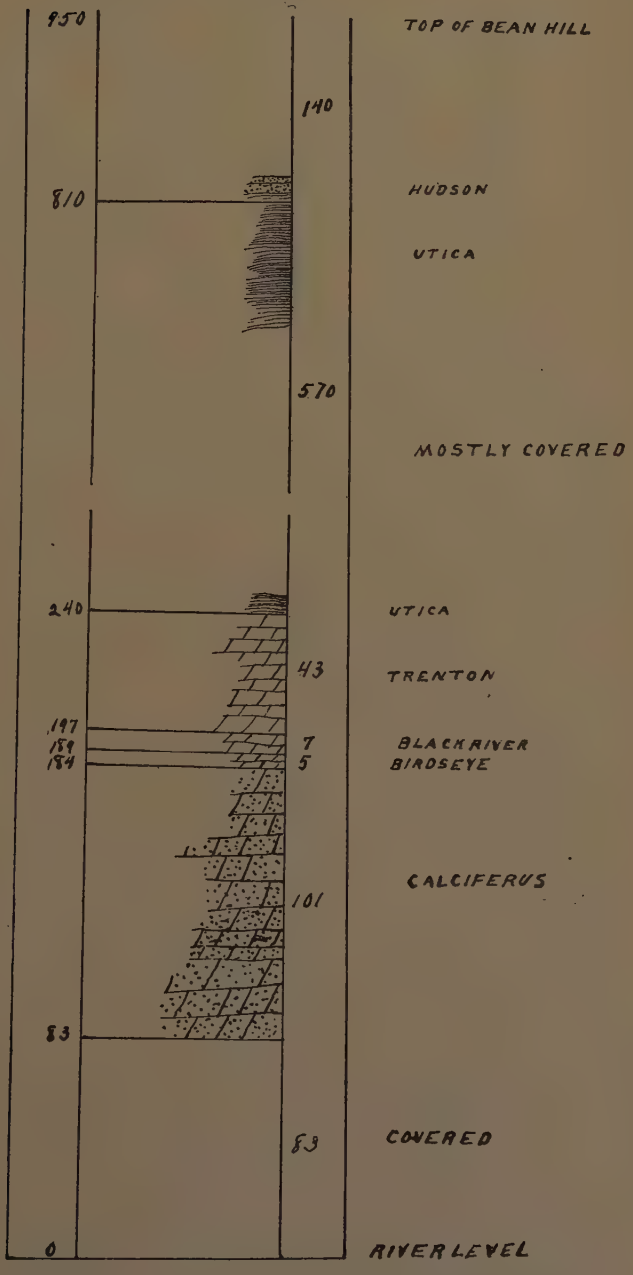
Since the description of the Pattersonville section appeared,[1] the Moore quarry has been worked extensively for the Erie canal, so that the character of the Trenton limestone is shown to better advantage than formerly. The following section from river level to the top of the Moore quarry is given for comparison with the former section.

	Feet
2 D^1 Covered from river level to ledges in the woods SSW of Pattersonville.	140=140
D^2 Partly covered. Some ledges of rough calcareous sandstone in which is some flint. Calciferous sandrock.	70=210
D^3 Drab, somewhat lumpy limestone in which are large masses of Columnaria alveolata Goldf. This is best shown in the little run below the Moore quarry where, in the small fall, are 7 feet, 6 inches.	$7\frac{1}{2}$=217$\frac{1}{2}$
D^4 Massive rather light gray limestone forming the lower part of the Moore quarry. Trenton limestone.	$10\frac{10}{12}$=228$\frac{1}{8}$
D^5 Shaly quite fossiliferous dark blue Trenton limestone.	6=234$\frac{1}{8}$

[1] 13th annual report N. Y. state geologist, p. 656-57, section 2B.

SWARTZTOWN CREEK
AND
BEAN HILL

WILLIAM L. FISHER



	Feet
D^6 Boulder clay in which are boulders of various sizes. The thickness varies in different parts of the quarry from 5 feet, 10 inches to 8 feet.	$8=242\frac{1}{3}$
D^7 Soil to top of the quarry.	$1\frac{1}{3}=243\frac{2}{3}$

The dip varies in different parts of this quarry from 2° to 5° S, 40° to 45°E. The Birdseye limestone does not appear to be represented in this section but it occurs at the eastern end of an old quarry below the highway a mile northwest of the Moore quarry. This is the most eastern outcrop of the Birdseye limestone that the writer has seen on the southern side of the Mohawk river.

Hoffman fault

The section on the northern side of the river from Hoffman to the top of Van Epp's hill and the fault have already been described by the writer[1] and by Mr Darton.[2] The gorge known as Wolf's hollow has been excavated for three fourths of a mile along the line of this fault. At its southern end near the point at which the highway turns to the east the foot wall composed of Calciferous sandstone forms a high cliff, the top of which is 150 feet above the creek level; while on the eastern side is the lower hanging wall of the Hudson river formation. Mr Darton referred the country to the east of the fault to the Utica slate; but at the lower end of the gorge there are heavy sandstone strata alternating with blackish to bluish shales which in Montgomery county mark the Hudson river formation to the lower part of which the writer refers these rocks. In places near the top of the Calciferous cliff, or foot wall, are exposures of Trenton limestone and farther up the glen apparently of Utica slate which dips very steeply to the east, having from all appearances dragged on the Calciferous sandrock when the displacement occurred. The fault scarp is again well shown to the north of the glen near the Weatherwax quarry at the corners a mile southwest of Glenville. At this locality 9½ feet of Trenton is shown on the eastern side and just to the east of the quarry along the fault scarp 12 feet, 2 inches of this limestone. The direction of the fault to the south of the

[1] 13th annual report N. Y. state geologist, p. 655-56, section 2A.
[2] 14th annual report N. Y. state geologist, p. 49, 50.

Weatherwax quarry is N30°E and at the southern end of the gorge N between 40° and 41° E.

There seems to be no published estimate of the throw or amount of displacement of this fault. If the thickness of the Utica slate along the line of the fault be as great as it appears to be south of Amsterdam, six miles to the west, then it must amount to some 1600 feet; since it would comprise the 1440 feet of the Utica slate[1] and the footwall of Calciferous sandstone 150 feet or more in hight.

SARATOGA COUNTY

Rock City falls section

At Rock City or Mill on the Kayadarosseras creek, six miles west of Saratoga Springs is an exposure from the upper part of the Calciferous sand rock well into the Trenton limestone. The section is as follows:

	Feet
12H[1] Massive Calciferous sandrock forming the falls. There are rolls in the upper part of the sandstone, and the top of the Calciferous on which the superjacent limestone was deposited is irregular.	12½=12½
H[2] Light dove colored limestone in which are a few small vertical fucoidal markings, probably Phytopsis tubulosa. Birdseye limestone.	1=13½
H[3] Texture similar to that of H[2] but most of the fucoidal markings are irregular, lateral shaped to horizontal. In the end nearer the creek, however, there are a few vertical markings which extend to the top of the 2 feet, 10 inches of dove colored, compact limestone. This stratum probably belongs in the Birdseye.	1 5/6=15½
H[4] Thin bedded, blocky limestone which is a sort of transitional Black river limestone.	1=16½
H[5] Thin bedded Trenton limestone extending to the top of the cliff and containing plenty of specimens of Rafinesquina alternata (Con.) Hall and Clarke associated with other fossils.	8½=25
H[6] Thin bedded limestone which becomes more massive in the upper part. 37½ feet of Trenton limestone exposed.	29=54

[1]15th annual report N. Y. state geologist, p. 650.

ROCK CITY FALLS OVER CALCIFEROUS SANDROCK; STUDENT STANDING ON ITS TOP WITH TRENTON LIMESTONE ABOVE

On the eastern side of the creek the Trenton limestone is the lowest rock exposed occurring along its bank both below and above the bridge and below the falls though not on a line with them but at a level from 8 to 10 feet lower. Mr Darton reported 3 feet of Birdseye sharply separated from the Calciferous sandstone which was the farthest east that he saw this limestone.[1] The Trenton he reported as 28 feet thick, "thin bedded members below with heavier bedded and slightly coarser grained beds above" (p. 427).

Saratoga Springs sections

Three miles west southwest of Saratoga Springs on Ellis creek at Rowland's mills is the Wing quarry where a considerable excavation has been made in the Trenton limestone. The section of this quarry is as follows:

	Feet
12E[1] Massive thick bedded limestone, some of the layers containing numerous fossils. Trenton limestone.	14=14
E[2] Shaly Trenton limestone.	5=19
E[3] Boulder clay varying in different parts of the quarry from 7 to 10 feet in thickness.	7=26
E[4] Champlain sand.	3=29
E[5] Soil.	

In the accompanying picture the students are standing on top of the shaly Trenton limestone and back of them is the boulder clay. Darton in his *Geology of the Mohawk Valley* mentions this quarry when he states that 20 feet of the Trenton formation was exposed at this locality which was called Howland's Mill (p. 427).

The stratum which forms the floor of this quarry and is better shown on the eastern side of the highway contains numerous and beautiful specimens of Cryptozoön proliferum Hall. This is the locality described by Prof. Hall when he states that "At a single exposure on the farm of Mr Hoyt, the surface of the limestone is covered by these bodies for many rods in extent"[2] and the limestone was referred to the "Calciferous sandstone". Later Mr Walcott referred a considerable thickness of so-called Calciferous in the vicinity of Saratoga Springs to the Potsdam stating that "This limestone was referred to the Calciferous forma-

[1] 13th annual report N. Y. state geologist, p. 423, 427.
[2] 36th annual report N. Y. state mus. nat. hist. 1883, description of pl. 6.

tion originally; the great Stromatopora-like bodies of Hoyt's quarry, four miles west of Saratoga, occurring in it."[1] The reasons for this correlation were given more fully by Mr Walcott at a later date.[2]

On the *Geologic map of New York* the line of division between the Potsdam and Calciferous at this locality is represented as following the highway with Calciferous on the western side. It was found, however, that from the foot of the bank on the eastern side of the road for 45 feet to a ledge seen on the western side of the road the rocks contain specimens of Lingulepis acuminata Con. associated with fragments of Potsdam trilobites. The old Hoyt quarry is in the midst of this 45 feet and gives the following section:

	Feet
12D[1] Massive impure limestone in lower part of quarry containing specimens of Lingulepis acuminata Con. and trilobites.	10=10
D[2] Not well exposed.	2=12
D[3] Massive rock in layers, the upper part containing Lingulepis and trilobites.	4½=16½

The Cryptozoön stratum is light gray, strongly calcareous and contains large numbers of this fossil; some of them were elongate, others somewhat circular and one by the side of the road had a diameter of 2 feet, 2 inches. This stratum is exposed by the side of the road just north of the three corners a short distance north of the Hoyt quarry and then is finely shown for some distance in the field to the northeast. The layer immediately below the Cryptozoön one in this field contains specimens of trilobites and other fossils.

In the southern part of Greenfield township not more than ½ mile northeast of the three corners north of the Hoyt quarry and 2½ miles northwest of Saratoga Springs are three cuts along the Adirondack railroad in the Potsdam sandstone. The most eastern one (12C), where the east and west highway crosses the railroad, shows a massive stratum of white quartzose sandstone varying from 1 foot, 9 inches to 2 feet in thickness. There are also shaly layers in which are fucoidal markings.

[1] Science, 1884, 3:137.
[2] U. S. geological survey, bul. 30, 1886, p. 21, 22, and ibid. bul. 81, p. 346.

TRENTON LIMESTONE IN WING QUARRY AT ROWLAND'S MILLS, WITH BOULDER CLAY ON TOP

Feet

A[2] About 15 feet of light gray calcareous sandstone shown in the wall of the quarry which separates into three beds; the lower one 7 feet, 6 inches in thickness, the middle one 4 feet and the top one 3 feet. There are masses of calcite and flint in the rock, also quartz crystals. The wall of this quarry is well shown in the accompanying picture. 15=55

A[3] Calciferous ledges partly covered to the edge of the woods. 30=85

Glens Falls sections

Along the banks of the Hudson river at Glens Falls are excellent exposures of the Trenton limestone, which has been extensively quarried. The Finch and Pruyn quarry on the northern bank of the river affords an excellent opportunity to study the different zones of this limestone as may be seen in the following section:

Feet

54B[1] A calcareous sandstone 2 feet of which was above the river level at the locality measured. This has usually been referred to the Calciferous formation[1] but Mr Walcott has stated that in the vicinity of Glens Falls he is "inclined to think that it is impossible to recognize, by lithologic characters, the Calciferous formation as distinct from the Chazy limestone horizon; and at Glens Falls Maclurea magna [a Chazy species] and great numbers of an Ophileta like O. compacta [a Calciferous species] are found in the same stratum of rock but a little distance beneath the Trenton limestone, an occurrence that renders it very difficult to state what is to be assigned to the Calciferous horizon in this region."[2] 2= 2

B[2] At the base of this zone is a shaly parting, then a limestone in which is a large specimen of Columnaria alveolata Goldf. and above is thin to thick bedded dark blue lumpy limestone, the thicker layers of which contain fossils. The Columnaria in this zone is apparently at the same horizon as that noted in Darton's section (p. 428). 25 2/3 =27 2/3

[1]13th annual report N. Y. state geologist, p. 424. *See* base of section on p. 428.
[2]U. S. geological survey, bul. 30, 1886, p. 22.

POTSDAM SANDSTONE IN 3′ CUT ON ADIRONDACK RAILROAD

Feet

B^3 Drab colored stratum similar in lithologic appearance to the Birdseye. $\frac{2}{3}$=28 $\frac{1}{3}$

B^4 Massive dark gray limestone forming the floor of the quarry. This stratum contains numerous specimens of Columnaria alveolata Goldf. and Buthotrephis succulens Hall which are specially well shown. 1=29$\frac{1}{2}$

B^5 Dark blue rather thin bedded limestone thickening toward the western end of the quarry. It is not, however, used for "marble" but burned for quicklime as is some of the rock from the next zone. 3 $\frac{5}{6}$=36 $\frac{1}{6}$

B^6 Massive, fine grained, dark gray, compact limestone, the "black marble" of the quarrymen. This zone which is in the Trenton limestone divides into three beds; the lower massive one 4 feet, 3 inches in thickness, the middle massive one 5 feet, 6 inches and the upper one composed of three thin layers 3 feet 2 inches. 12 $\frac{2}{3}$=45 $\frac{5}{6}$

B^7 Thin shaly limestones extending to the top of the quarry. 12$\frac{1}{2}$=58$\frac{1}{3}$

The dark gray compact limestone of zone B^6 when sawed is capable of taking quite a polish and this has suggested the name of marble. The characters of the Black river and Birdseye subformations appear to be so blended in this quarry that it becomes difficult to separate them. The following section was measured on the south bank of the Hudson river immediately below the street bridge between Glens Falls and South Glens Falls:

Feet

$54A^1$ Drab colored limestone with vertical markings like Phytopsis tubulosa Hall. 11 inches measured at the water's edge and possibly 1 foot in thickness. The rock is very compact and fine grained but darker in color than the Birdseye limestone in the Mohawk valley though it weathers to a similar light gray color. The equivalent of zone B^3 on the north bank. 1=1

A^2 Dark gray to bluish, lumpy limestone containing Columnaria alveolata Goldf., Streptelasma and some other fossils as well as black

Feet

chert. The beds are thinner than those of the overlying limestone. Apparently the equivalent of zones B^4 and B^5 on the north bank. 5=6

A^3 Massive light to dark gray crystalline limestone varying in thickness from 11 feet, 6 inches to 12 feet. It contains numerous crinoid segments and is in the Trenton limestone. Represents the "marble" beds or B^6 of the north bank. 12=18

A^4 Thin bedded, dark blue limestones containing Trenton brachiopods. Under the highway bridge and equivalent to zone B^7 of the north side. The dip as measured on this bank varies from 4° to 5½°S 80°W. Another dip of 2°S 10°E was measured. 18=36

On the south bank of the river below the paper mill are quarries, the lower ones being worked for "marble" and the upper for massive limestone. The section of the bank at this locality is as follows:

Feet

$54C^1$ Thick bedded, dark blue limestone. The same zone as B^5 on the north side and with the same thickness. $3\frac{10}{12} = 3\frac{10}{12}$

C^2 The "marble" beds of the old quarries. $12\frac{9}{12}=16\frac{7}{12}$

C^3 Thin bedded limestone with Trenton fossils. $14=30\frac{7}{12}$

C^4 Thicker bedded, more crystalline layers in which are the upper quarries. $13\frac{6}{12}=44$

C^5 Thin bedded limestones to the top of the cliff. $19\frac{1}{2}=63\frac{1}{2}$

Correction. In the paper on the *Sections and thickness of the Lower Silurian formations on West Canada creek and in the Mohawk valley*, published in the *15th annual report*, a mistake was made in the plates so that pl. 10 is stated to represent the "Falls in Flat creek, Sprakers, over the Calciferous sandstone," when in reality it represents a view of the falls in the Oniskethau creek, Albany county, over Esopus shales.

CALCIFEROUS SANDSTONE QUARRY IN NORTHERN PART OF SARATOGA

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